Penchala Akshay Kumar Kandagaddala

U35865522

Business Analytics & Information Systems

Spring 2023.

Final Project Report

The relationship between air pollution and Global Agricultural Production.

Data Visualization

Prof. Johannes Reichgelt, PhD

Introduction

Air pollution is the presence of hazardous substances and particulate in our planet's atmosphere. Both natural causes, such as volcanic eruptions and wildfires, and human activities, such as transportation, energy production, and industrial processes, can generate these pollutants. Moreover, air pollution can alter the composition of the atmosphere, resulting in changes to climate patterns that can have an impact on agriculture. This can lead to variations in temperature and precipitation, which can hinder crop growth and yield and influence the spread and severity of pests and diseases.

The influence of air pollution on agricultural production dates to the industrial revolution. As factories and transportation systems propelled by fossil fuels proliferated, so did the emission of air pollutants. As early studies documented the harm caused by sulfur dioxide and other pollutants, the negative effects of these emissions on crop health and yield became readily apparent. With this report, I tried to explore different countries and their plastic waste produced each year concerning the per capita income for the years 2010 and 2015.

Fact:

Ozone, a prevalent air pollutant, can reduce crop yields significantly. Studies have demonstrated that crops such as soybeans, maize, and cotton can experience yield losses of up to 20% when exposed to high levels of ozone, with some regions of the globe experiencing ozone levels that exceed safe crop growth thresholds.

Ambitiousness:

The impact of air pollution on agricultural production is a pressing global concern that requires immediate action. Given that air pollution causes substantial harm to crops, livestock, and food security, it is crucial to employ effective measures to reduce emissions and mitigate their detrimental effects.

According to the Food and Agriculture Organization of the United Nations, air pollution causes significant agricultural losses worldwide, with some estimates indicating that it reduces global crop yields by as much as 11 percent.

This calls for a concerted effort to transition to healthier energy sources, enhance transportation systems, and promote sustainable agricultural practices. It also necessitates a greater investment in research and development to create innovative answers to the complex problems posed by air pollution and its effect on agriculture.

Research questions presented in the project:

The research questions I attempted to address were:

1. What is the trend of average CO2 emissions over the years?

2. What is the average AQI value of the cities compared to other cities in a respective country?

3. How does the annual variation in CO2 emissions correlate with changes in the area harvested for agricultural production??

4. What is the relationship between absolute number of deaths and CO (carbon monoxide) exposure?

5. What is the impact of different pollutant emissions on different agricultural yields?

As air pollution is a growing concern for agricultural production, the purpose of this study is to investigate the impact of air pollution on agricultural production to inform the development of effective mitigation strategies.

Data set references:

Most of the data used in the analysis came from:

1. https://ourworldindata.org/co2-emissions

2. http://data.un.org/Explorer.aspx

3. https://www.who.int/data/gho/data/themes/air-pollution

4. https://data.world/oecd/crop-production

5. https://www.fao.org/faostat/en/#definitions

Methodology

The data sources used to generate the visualizations are derived from the data sheets retrieved from the referenced websites. These datasets are normalized for their respective populations so that they can be visualized consistently. Each data source is important in its own way. For instance, the emissions generated by air pollutants namely Ammonia, Black Carbon, Carbon Monoxide generated in each year are connected to the per capita of the population for the same year. The top 10 countries PM 2.5 per capita emission and their Yield produced should be considered a significant visualization. Since it helps in answering various research questions.

Similarly, because air pollution has a negative impact on crop production, it is essential to investigate its sources and causes, such as industrial processes and transportation, to identify the industries that produce the most pollutants and to develop effective mitigation strategies. Additionally, it is essential to investigate the effects of air pollution by Volatile organic compounds and the resulting mismanagement of pollutants to reduce the impact on crop production.

Frequently used column names in tables:

Code, Entity: It includes every country code in the world, according to the ISO country code.

Year: It consists of the years that are related to the data associated with it.

Per Capita Co2 Emissions: Total Per Capita Co2 emissions of a respective country over the years.

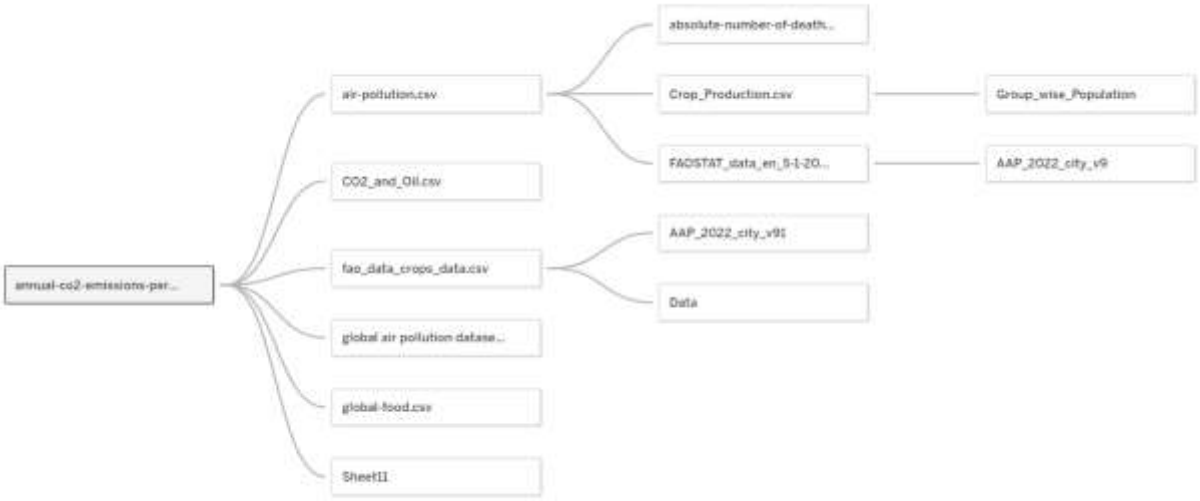
Top N Countries: A parameter used to display the best-performing countries for a particular research question.

Area_Harvested_Ha_Per_Capita: This provides statistics about the area of the land harvested globally in a respective country in a year.

WHO region: It provides the region to which a particular geographic location or country belongs to.

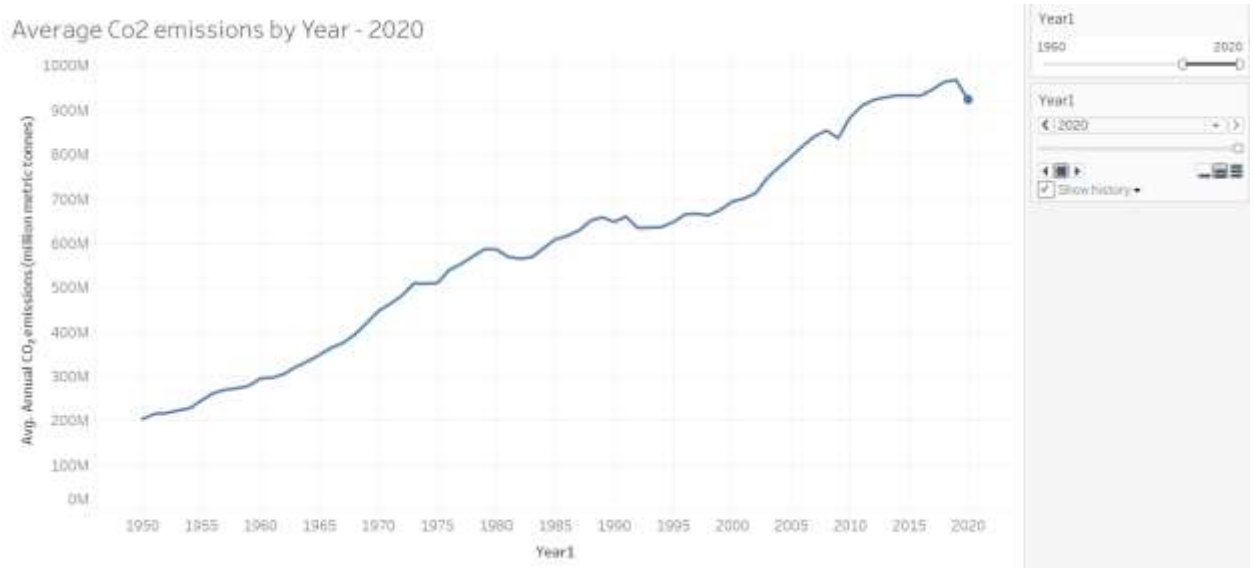
Yield(tonnes_per_hectare): It provides the normalized data about the yield produced for the crop in a year for the respective country.

There are a total of 12 data sources, each with their own significance. If in the future a datasheet contains information related to air pollution or crop production data, then this information can be connected and used for visualizations and further research. The relationship diagram for these data sources has been displayed below which clearly states how the common entities are merged which helped to create a relationship and extract meaningful insights.



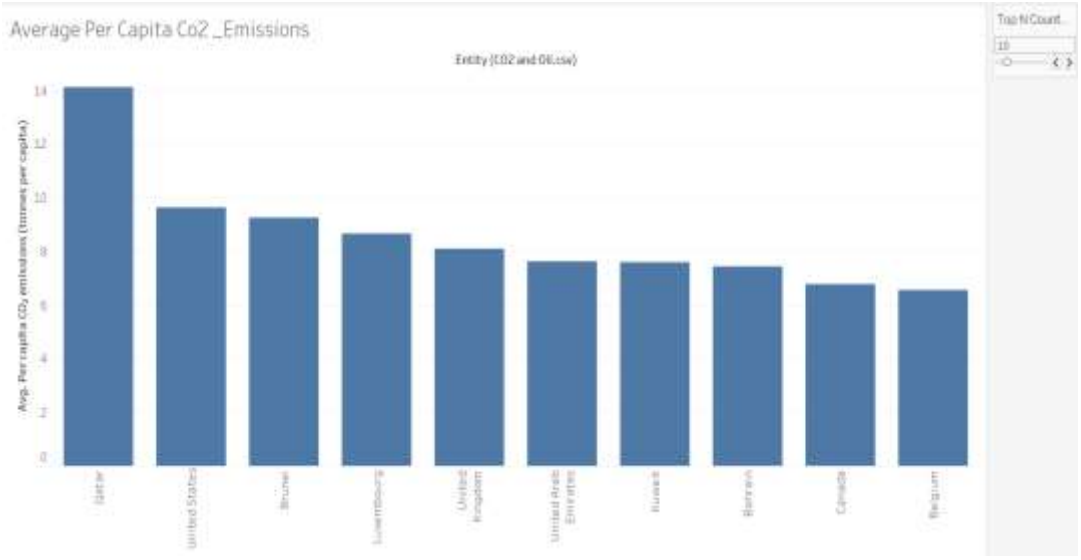
Analysis Performed:

1. **<u>Average Co2 emissions by Year from 1950 - 2000</u>**



To address the research questions, it is essential to identify the trends in pollutant emissions over the years, as air pollution is central to the overall undertaking. From 1950 to 2020, plastic production has increased exponentially, as shown by the above line graph. From 2 million in 1950 to 950 million in 2020, its size increased. This indicates that CO2 emissions have increased over time. It is essential to determine the causes of this increase.

2. Average Per Capita Co2 _Emissions

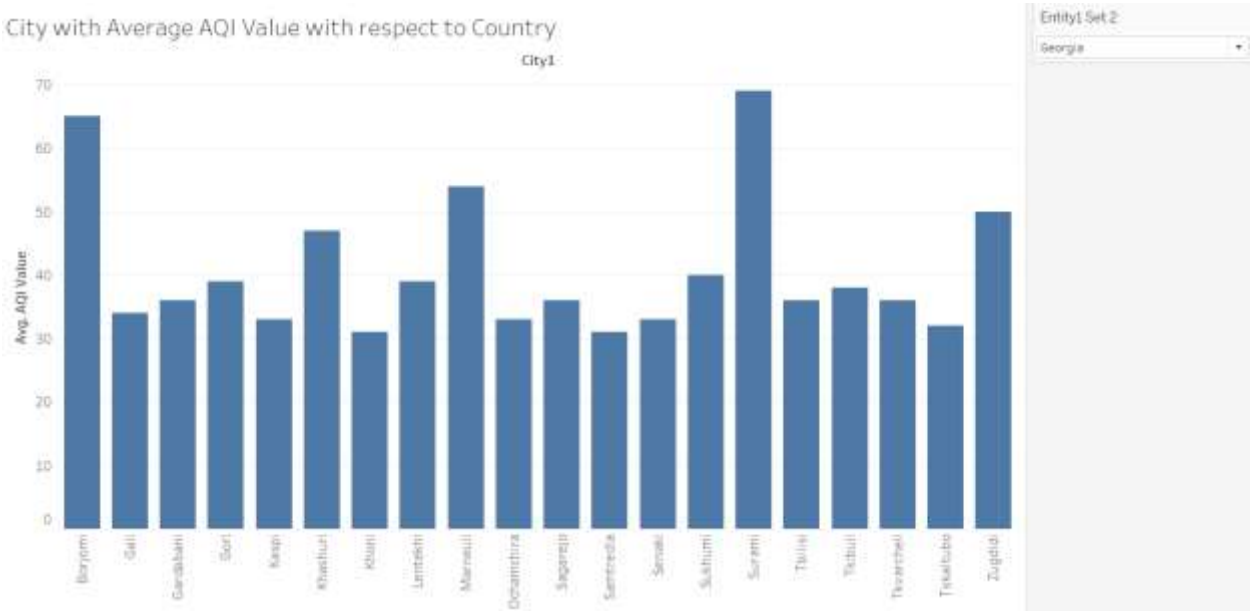


According to the preceding visualization, Qatar is the nation with the highest CO2 emissions per capita. I have used the Top N Countries filter to display the ten countries with the highest per capita co2 emissions. Here, I have normalized the data regarding the population of each country. Here, I chose a bar chart because it clearly displays the information about each country. We can conclude from this that it is not true that countries with the highest population have the greatest CO2 emissions.

3. Per capita Co2 Emissions by Country for each year

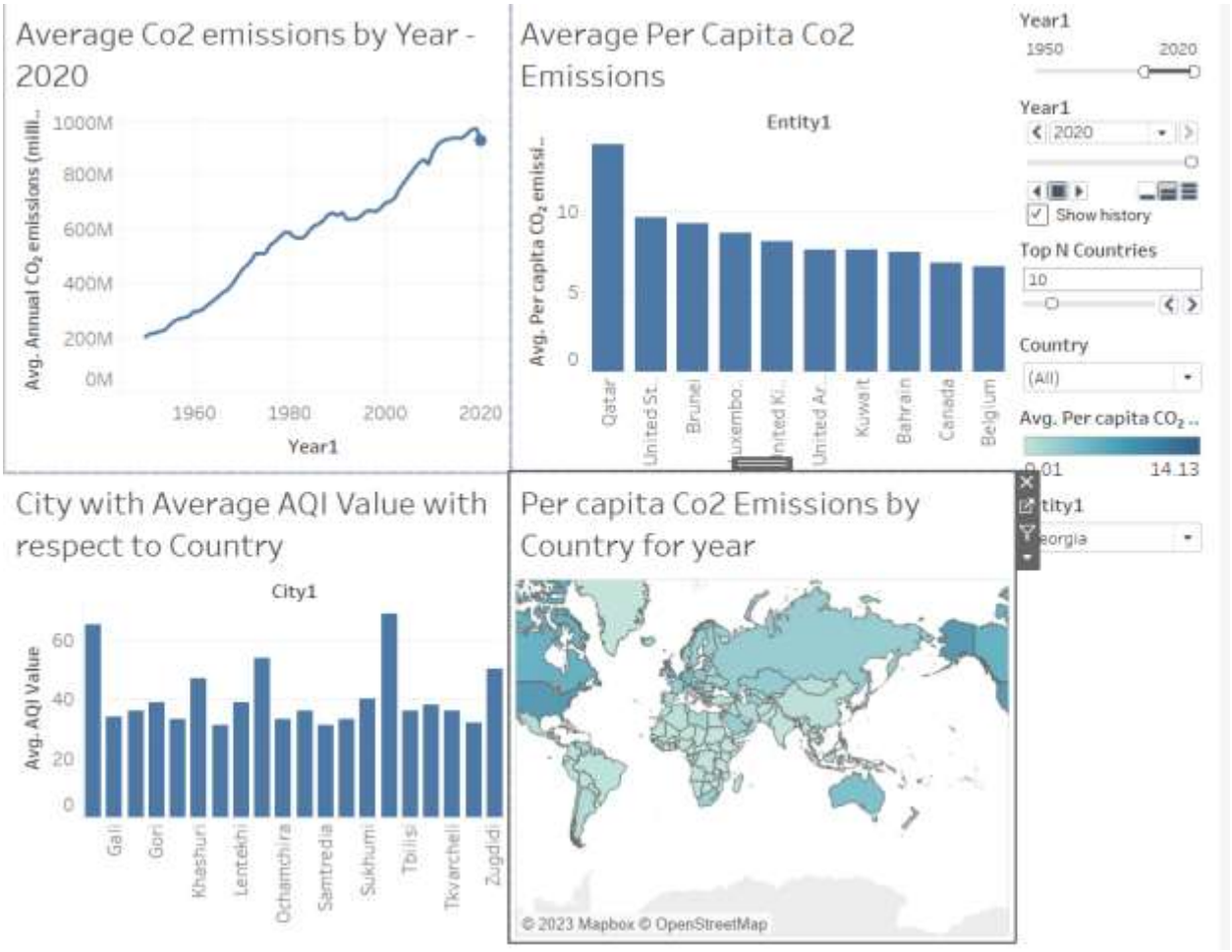
The chart shown above provides information on the nation with the most annual per capita CO2 emissions. It displays this information in detail for every nation between 1950 and 2020. To properly illustrate this information year by year, I have utilized the map and animation here. The states are ordered by color, from dark blue to light blue for those with the greatest to lowest per capita CO2 emissions, accordingly.

4. City with Average AQI Value



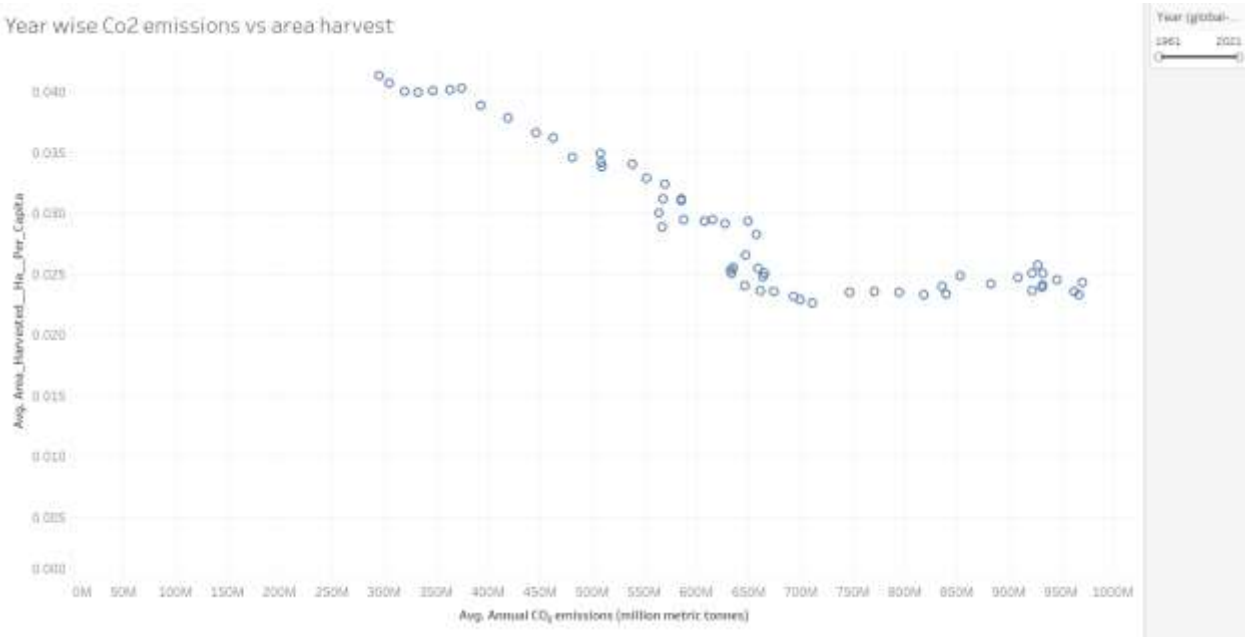
Information about the cities' Air Quality Indexes across all nations is shown in this bar graph. Data about each city's degree of pollution is shown via the Air Quality Index. The bigger the AQI, the higher the amount of air pollution and danger to health. I used a filter for the country over here. Therefore, by selecting the country in the filter, it is possible to view the cities that are present in the relevant country along with their AQI value.

5. Air Quality Testing Dashboard:



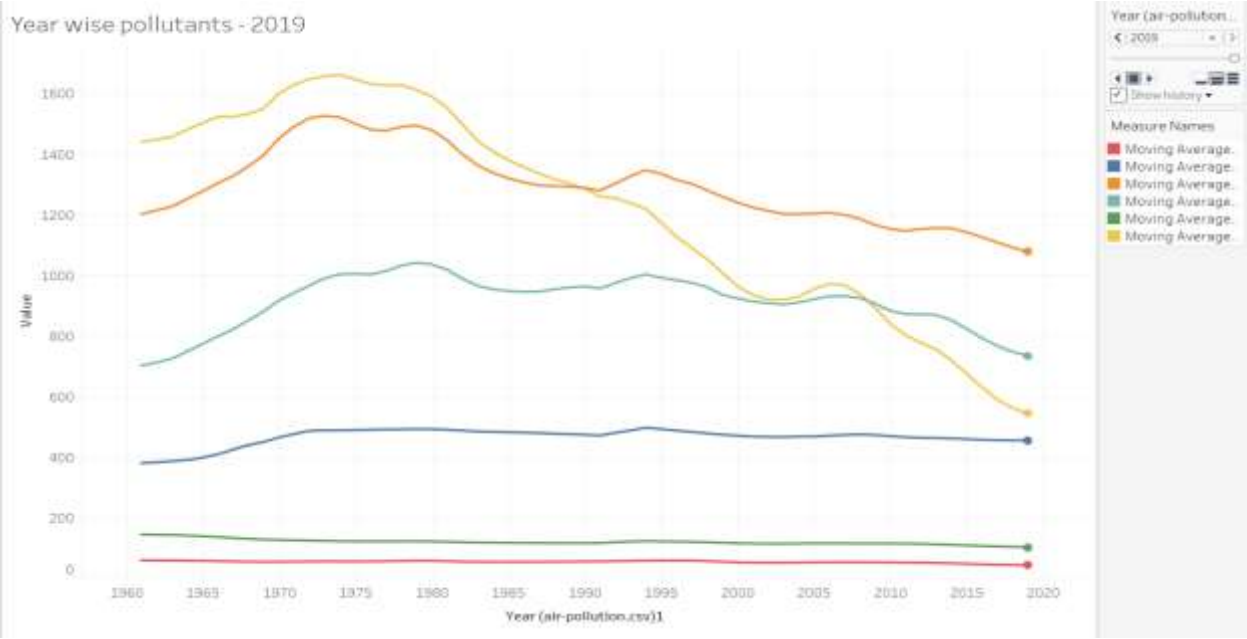
This dashboard can give an outline of the air quality and carbon pollution in different cities of regions, making it easy to find areas of concern and focus actions. By putting CO2 emissions and AQI values on the same dashboard, users can quickly see how much carbon is being released and how much air pollution is happening as a result.

6. Year wise Co2 emissions vs Area Harvested:



This scatter plot displays information about the correlation between the Year wise Co2 emissions Vs Area of land Harvested. I have filtered the data from 1961 to 2021 here. I have normalized the data here for ease of analysis. It is evident from the graph that in the year 1961 the area of land harvested is more when compared to the co2 emissions observed that year. The area of land harvested has come down over the years and the emissions of Co2 have increased. This clearly shows that the air pollution has increased over the years, and it created a huge impact on agriculture production.

7. Year wise different pollutant emissions:

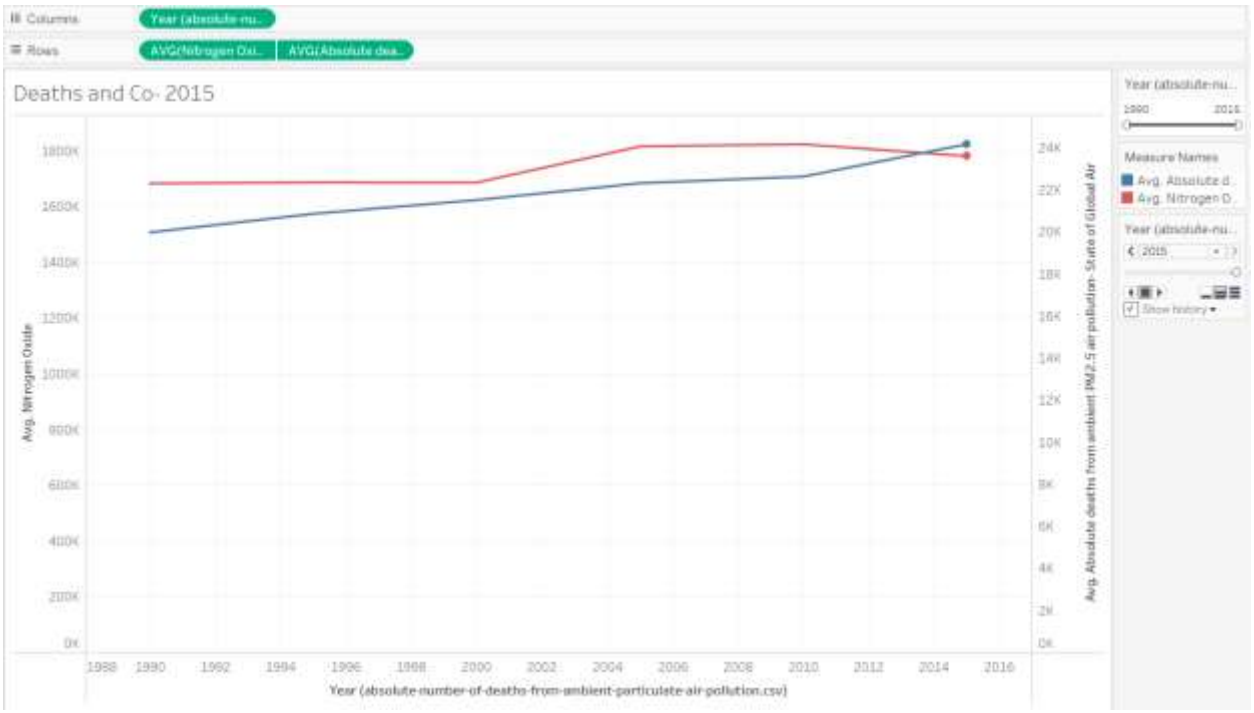


This visualization provides insights about the emissions of different air pollutants over the years. The emissions of Ammonia, Black Carbon, and Organic carbon showed a very less significant change over years. Whereas Nitrogen, NMVCO's and Black Carbon showed a significant change over the years. From this graph, we can conclude that the air pollutant emissions are fluctuating each year and make a great impact on the environment.

8. Top 10 Countries and Cities with Ozone, PM 2.5 Value:

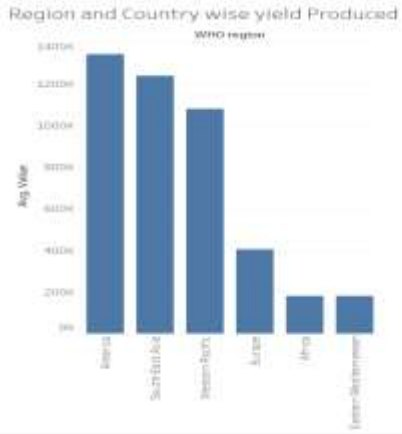
In this graph, I have used a clustered chart to display information about the emission of Ozone and PM 2.5 value in each country. I have used the Top N countries parameter to display the top 10 countries with the highest Ozone and PM 2.5 value. I have also used a hierarchy here to display the cities present in each country when we drill down. This will clearly show the information in each country and the city present in each country.

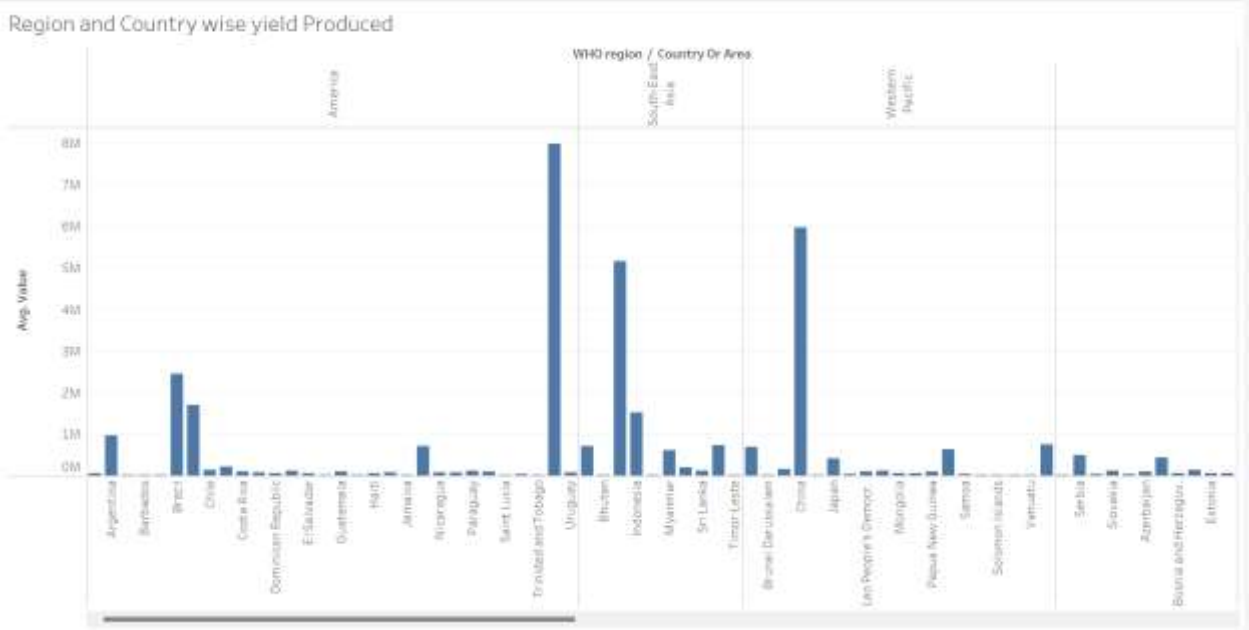
9. Relation between Deaths and Carbon Monoxide:



In this visualization, I have used a dual axis chart to clearly display the information about the Nitrogen Oxide emissions over the years with respect to the number of deaths that occurred in the same period. It is evident that the increase in the Nitrogen oxide quantity in the air shows the significant increase in the Absolute number of deaths reported in that particular year. This shows that Nitrogen oxide created a huge impact on the deaths reported in that particular year.

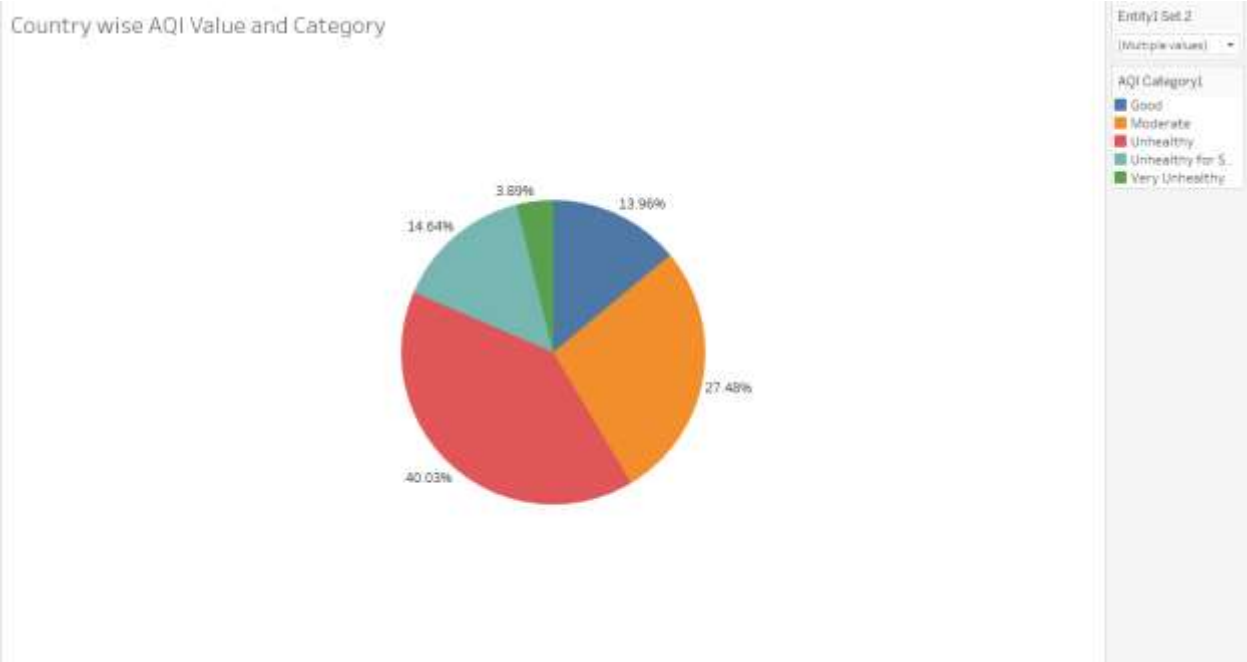
10. Region and Country wise yield Produced:





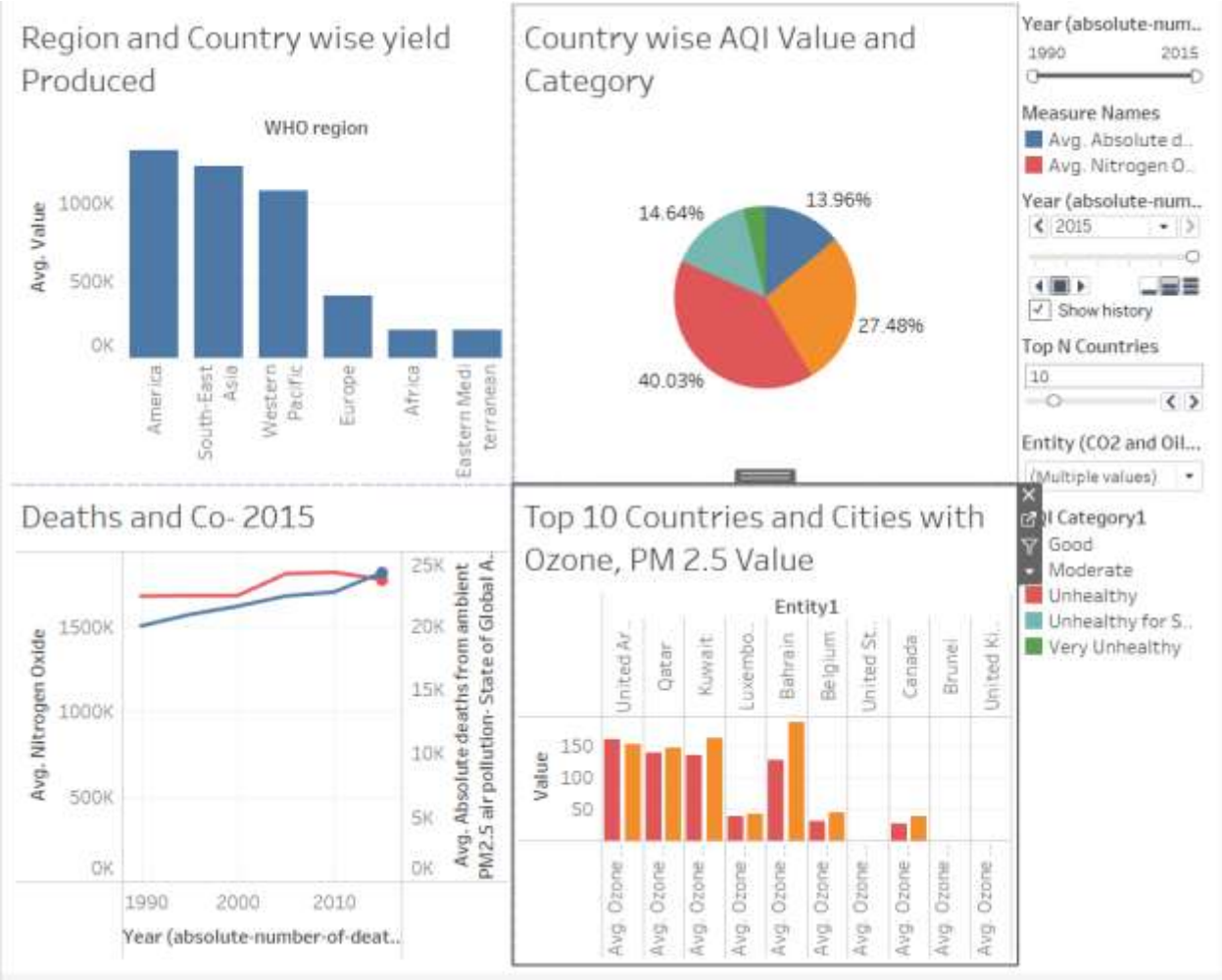
This above graph displays the yield generated in each region of the world. I have used a hierarchy here to display the countries present in each region that contribute to the yield production for that region. This will provide deep insights into the region's yield production and how it got impacted due to the air pollution.

11. Country wise AQI Value and Category:



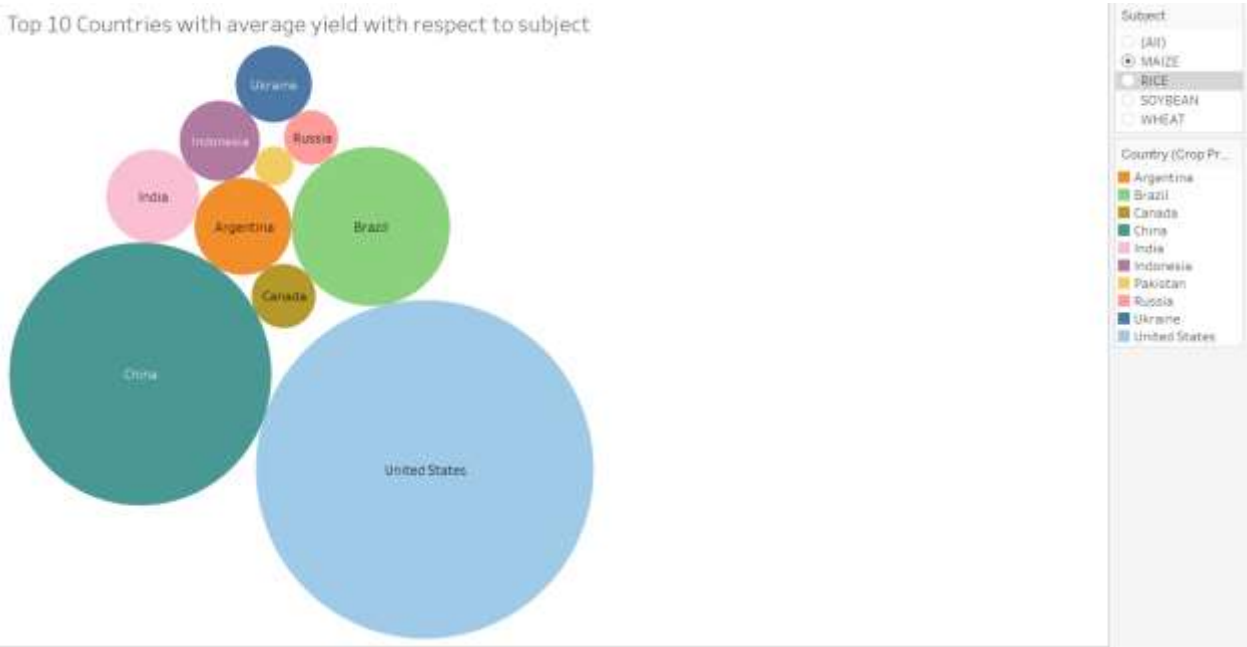
I have used a pie chart to display the proportion of the Air Quality Index categories of each country. I have put a filter for the country to get the information about the AQI category percentage for each country. This information will help to provide insights into each country's air pollution status and will help to act with respect to the percentage.

12. Emissions Vs Yield Harvested:



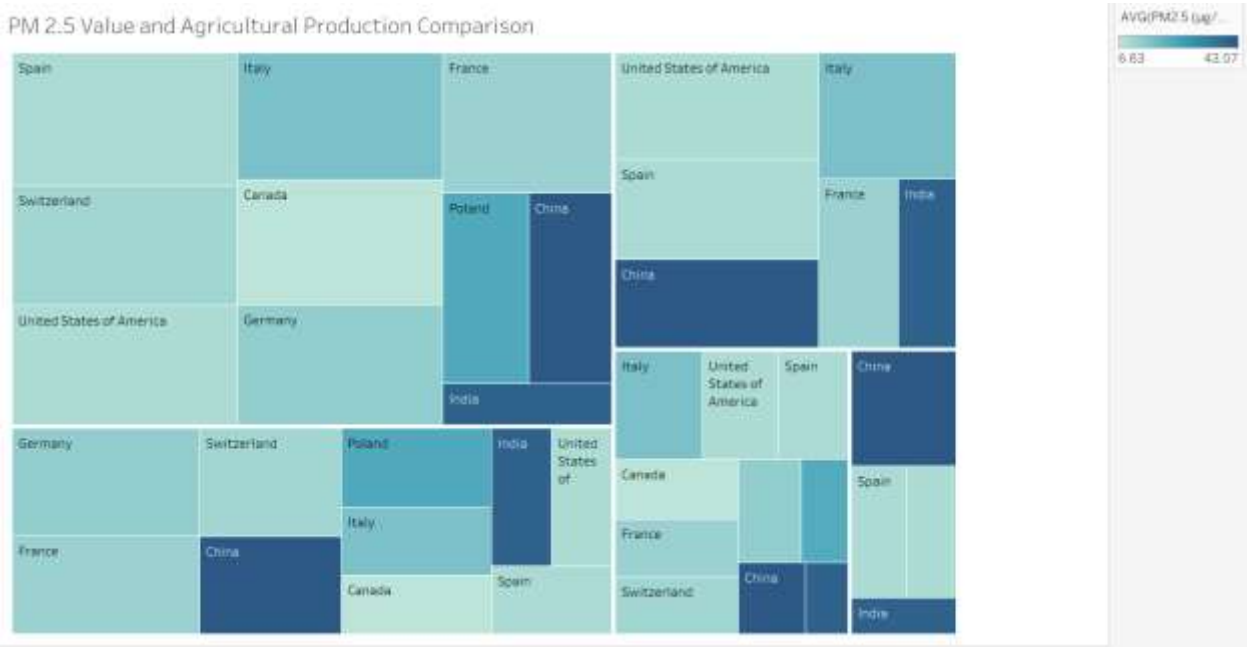
This dashboard can provide a quick and easy way for people to monitor and analyze the yield produced in different countries, along with the corresponding AQI values. By presenting this information in a single dashboard, people can quickly identify any patterns or correlations between yield and air quality, and make informed decisions based on the data.

13. Top 10 Countries with average yield with respect to subject:



This bubble chart displays information about the top 10 countries that produce highest yield for the respective subject. I have selected only Maize, Rice, Soybean and Wheat as these are more vulnerable to the air pollutants. From the above graph, it is evident that Maize is more produced in United States followed by China.

14. PM 2.5 Value and Agricultural Production Comparison:

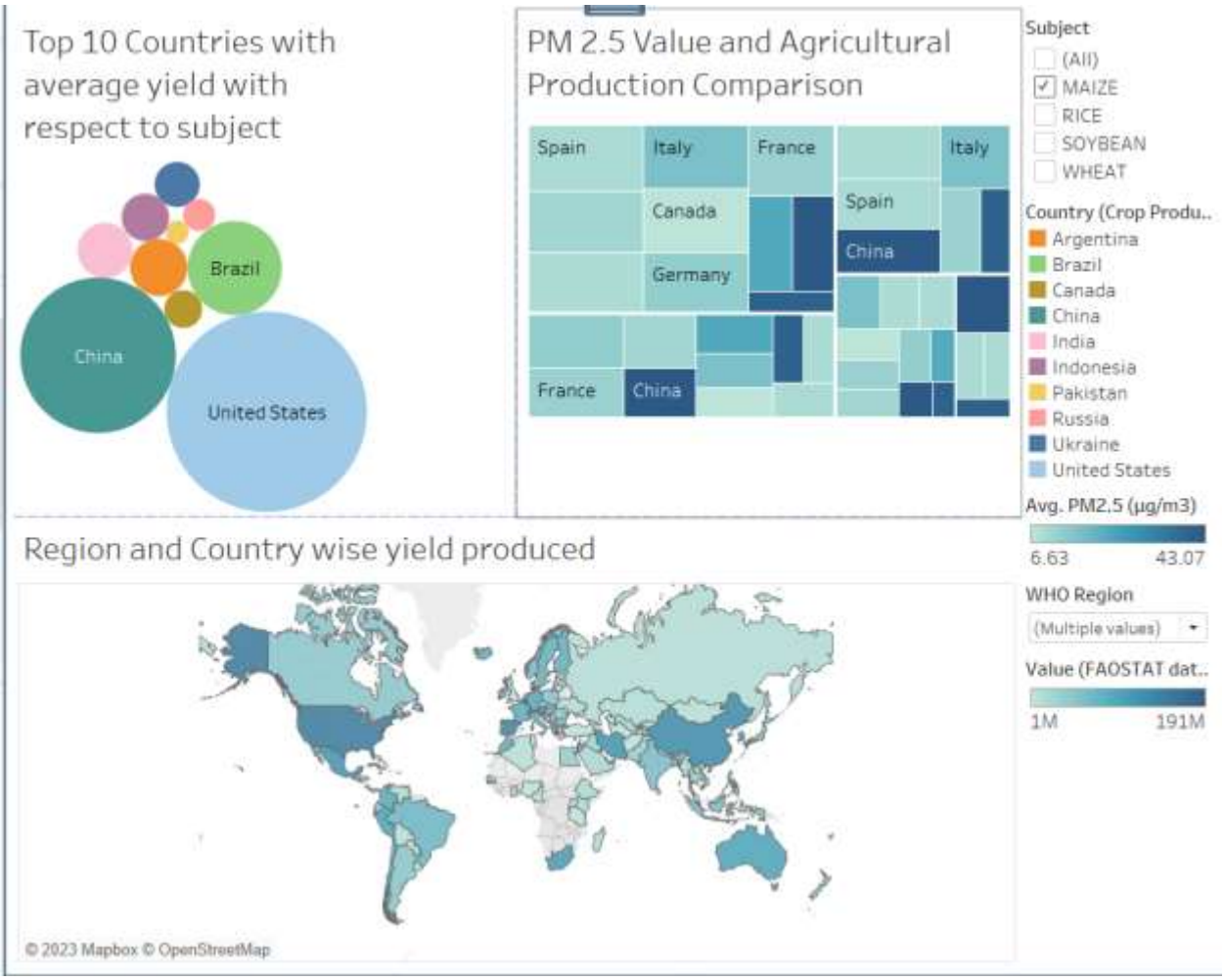


In this Visualization, I have displayed information about the Average PM 2.5 AQI value and agricultural production. The lower the Air Quality Index, the higher the Agricultural Production in that respective country. From the above tree map, Spain has the lower AQI value which accounts for the highest Agricultural production and India records the highest PM 2.5 AQI value with the lowest Agricultural Production.

15. <u>Region and Country wise yield produced:</u>

In this Visualization, I have displayed information about the agricultural production observed in different regions. I have created a region filter that will help to navigate through different regions. This will create a better understanding about the region wise yield production that helps to extract meaningful insights.

16. <u>Region and Country-wise Yield Production Dashboard:</u>



This dashboard may be used to assist in the identification of regions that are especially susceptible to the negative effects that air pollution can have on agricultural practices. For instance, if the data reveals that some regions have high concentrations of PM2.5 while simultaneously having poor crop yields, this may suggest that these regions are especially at risk from the adverse consequences of air pollution. Using this information, targeted interventions to improve air quality and support sustainable agriculture in these areas can be developed.

Conclusion:

Hence from the above visualization, I was able to answer my research questions. There has been a significant increase in the co2 emissions over the years and I was able to identify the city with the average AQI value in a country to calculate the Pollution level in that city. The highest number of deaths due to air pollution was reported in 2021. The area of land harvested is very minimal when compared to the initial years. Spain encountered the least AQI, and the highest yield production followed by Switzerland and USA.

Future Research Questions:

1. What are the mechanisms by which air pollution affects agricultural productivity? For example, does air pollution affect soil health, nutrient availability, or plant physiology?

2. What are the economic impacts of air pollution on agriculture, in terms of lost productivity, increased costs of inputs, and reduced crop quality?

3. What policy interventions can be implemented to reduce air pollution and protect agricultural productivity?

4. How can precision agriculture technologies be used to mitigate the impacts of air pollution on crop yields?

5. How does air pollution impact food security and access to nutritious food, particularly in low- and middle-income countries?