

Data Visualization

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Prof. Johannes Han Reichgelt, PhD

Final Project Report

Understanding Global Climate Change: Trends, Correlations, and Impacts

By

Taraka Sai Srinatha Reddy Vanukuri

U49174313

Business Analytics and Information Systems

Introduction:

Climate change has been a major global issue for several decades now, with its impacts being felt across various aspects of human life and the natural environment. The changes in global temperature, atmospheric composition, and natural phenomena have been attributed to various human activities, including burning of fossil fuels, deforestation, and industrialization. In this project, I explore the trends and correlations of greenhouse gas emissions, temperature changes, population growth, and air pollution along with its impact on human mortality rates.

This project is ambitious as it covers a broad range of topics related to global climate change, including greenhouse gas emissions, the correlation between emissions and economic growth, air pollution contributors, and deaths caused by air pollution.

Research Questions that I tried to address in this project:

1. How have the global trends in CO₂ concentrations, temperature emissions, and population growth changed over the last five decades, and how are they dispersed among different parts of the globe?
2. Is there a correlation between the levels of greenhouse gas emissions and the growth of GDP in different countries over the years, Top GHG emitters and Average GHG to GDP Ratio by Countries and Years?
3. How do variations in the types and amounts of air pollutants emitted by different countries over time relate to differences in per capita emissions and the health impacts of air pollution worldwide?
4. What are the impacts of indoor and outdoor air pollution on human health and which countries are most affected by air pollution-related deaths?

Methodology:

For this project, I gathered my data from numerous websites. To clean the data to my specifications for the research questions, I had to use Python and web scraping. The information was obtained from the websites listed below.

Dataset-1:

death-rates-from-air-pollution.csv- <https://ourworldindata.org/air-pollution>

A dataset on human mortality being caused by air pollution.

The Original data had deaths caused by air pollution across the world. I had to combine various data sets like deaths caused by indoor air pollution, deaths caused by outdoor air pollution etc., by using web scraping and python to answer my research questions.

Columns:

- a. Entity - Contains the list of country names across the world
- b. Years- Contains years from 1990-2017
- c. Air pollution (total) (deaths per 100,000)- Total deaths per 100,000 caused by air pollution across the world.
- d. Indoor air pollution (deaths per 100,000)- Total deaths per 100,000 caused by indoor air pollution across the world.
- e. Outdoor particulate matter (deaths per 100,000)- Total deaths per 100,000 caused by outdoor air pollution across the world.
- f. Outdoor ozone pollution (deaths per 100,000)- Total deaths per 100,000 caused by outdoor ozone pollution across the world.

Dataset-2:

gdp.csv- <https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG>

Gross domestic product is the monetary value of all finished goods and services made within a country during a specific period.

The Original data had GDP for every year across the world. I had to group by years and countries and remove unnecessary data by using python to answer my research questions.

Columns:

- a. Country Name- Contains the list of country names across the world
- b. Years- Contains years from 1961-2013
- c. GDP Growthpercapita- Contains the data about GDP growth across the world

Dataset-3:

air-pollution.csv- <https://ourworldindata.org/explorers/air-pollution?uniformYAxis=0&country=USA~CHN~IND~GBR~DEU&Pollutant=All+pollutants&Fuel=From+all+fuels+%28Total%29&Per+capita=false>

Air pollution is a mixture of solid particles and gases in the air.

The Original data had different gases causing air pollution for every year across the world. I had to group by years and countries and remove unnecessary data by using python to answer my research questions.

Columns:

- a. Nitrogen oxide- Nitrogen oxides (NO_x) are gases that are mainly formed during the burning of fossil fuels. Exposure to NO_x gases can have negative impacts on respiratory health. NO_x gases can also lead to the formation of ozone – another air pollutant.
- b. Sulphur dioxide- Sulphur dioxide (SO₂) is an air pollutant formed from the burning of fuels that contain Sulphur, such as coal. SO₂ is one of the main chemicals that forms acid rain.
- c. Carbon monoxide (CO)- Carbon monoxide (CO) is a pollutant produced from the incomplete combustion of carbon-based fuels such as oil, gas, wood, and coal.
- d. Organic carbon (OC)- Organic carbon molecules are formed from the incomplete burning of organic materials. This can come from the burning of fossil fuels (which are carbon-based organic material) or biomass. Organic carbon aerosols can also be suspended in the air from sources such as vehicle tyres and roads. Organic carbon molecules can contribute to particulate matter pollution, with negative impacts on human health.
- e. NMVOCs- Non-methane volatile organic compounds (NMVOCs) are pollutants formed from the burning of biomass and fossil fuels. NMVOCs can lead to the formation of other local air pollutants, such as ozone.
- f. Black carbon (BC)- Black carbon (BC) is a soot-like pollutant formed from the burning of biomass and fossil fuels. It is a major contributor to particulate matter pollution and contributes to climate change by absorbing sunlight.
- g. Ammonia (NH₃)- Ammonia (NH₃) is a gas which can mix with other gases – such as nitrogen oxides and Sulphur dioxide – to form particulate matter. Its main sources are the use of manure and fertilizers in agriculture, and emissions from industry.
- h. The remaining columns contain the same gases per capita emissions.

- i. Years- Contains years from 1961-2013
- j. Country Per Capita- Contains the list of country names across the world.

Dataset-4:

GlobalLandTemperaturesByCountry.csv-

<https://www.kaggle.com/datasets/berkeleyearth/climate-change-earth-surface-temperature-data?select=GlobalTemperatures.csv>

In earth science, global surface temperature is calculated by averaging the temperature at the surface of the sea and air temperature over land.

The Original data had temperatures for every year across the world. I had to group by years and countries and remove unnecessary data by using python to answer my research questions.

Columns:

- a. Entity - Contains the list of country names across the world
- b. Years- Contains years from 1961-2013
- c. AverageTemperature - Contains the data about average temperatures across the world.

Dataset-5:

ghg.csv- <https://ourworldindata.org/greenhouse-gas-emissions#per-capita-greenhouse-gas-emissions-how-much-does-the-average-person-emit>

Greenhouse gases are substances which absorb infrared radiation reflected from the Earth's surface and release this radiation back towards the earth, warming the planet in the process.

The Original data had Ghg for every year across the world. I had to group by years and countries and remove unnecessary data by using python to answer my research questions.

Columns:

- a. Country Name- Contains the list of country names across the world
- b. Years- Contains years from 1961-2013
- c. Greenhouse gas emissions per capita- Contains the data about GDP growth across the world

Dataset-6:

population.csv- <https://data.worldbank.org/indicator/SP.POP.TOTL>

A population is the complete set group of individuals, whether that group comprises a nation or a group of people with a common characteristic.

The Original data had populations for every year across the world. I had to group by years and countries and remove unnecessary data by using python to answer my research questions.

Columns:

- a. Country Name - Contains the list of country names across the world
- b. Years- Contains years from 1961-2013
- c. Count - Contains the data about total population across the world.

Dataset-7:

Co2ByYear.csv- <https://www.kaggle.com/datasets/ucsandiego/carbon-dioxide?resource=download>

Carbon dioxide (CO₂) is an important heat-trapping gas, or greenhouse gas, that comes from the extraction and burning of fossil fuels.

The Original data had Co₂ Concentrations Monthly for every year. I had to group by years and remove unnecessary data by using python to answer my research questions.

Columns:

- a. Years- Contains years from 1961-2013
- b. Co₂- Average Co₂ concentrations in Ppm

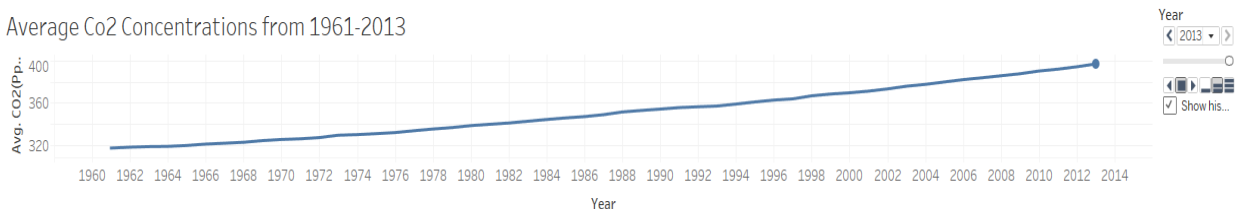
Analysis:

1. How have the global trends in CO2 concentrations, temperature emissions, and population growth changed over the last five decades and how are they dispersed among different parts of the globe?

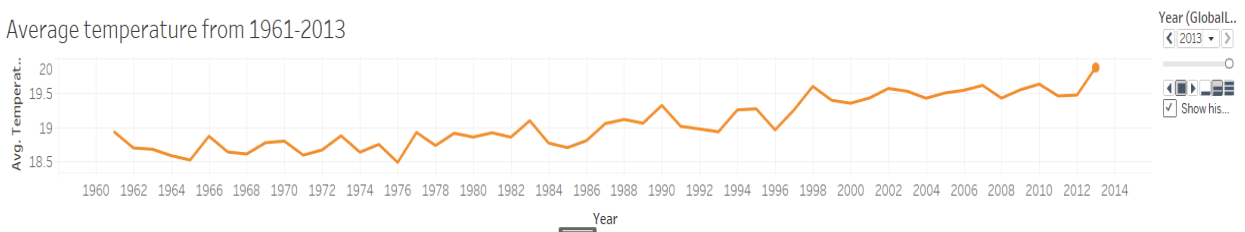
Solution:

Global Climate Change: How have the global trends in CO2 concentrations, temperature emissions, and population growth changed over the last five decades.

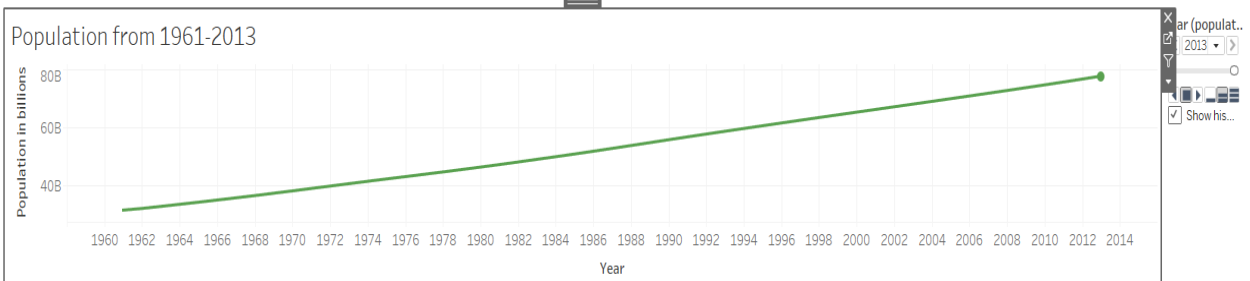
Average Co2 Concentrations from 1961-2013



Average temperature from 1961-2013



Population from 1961-2013

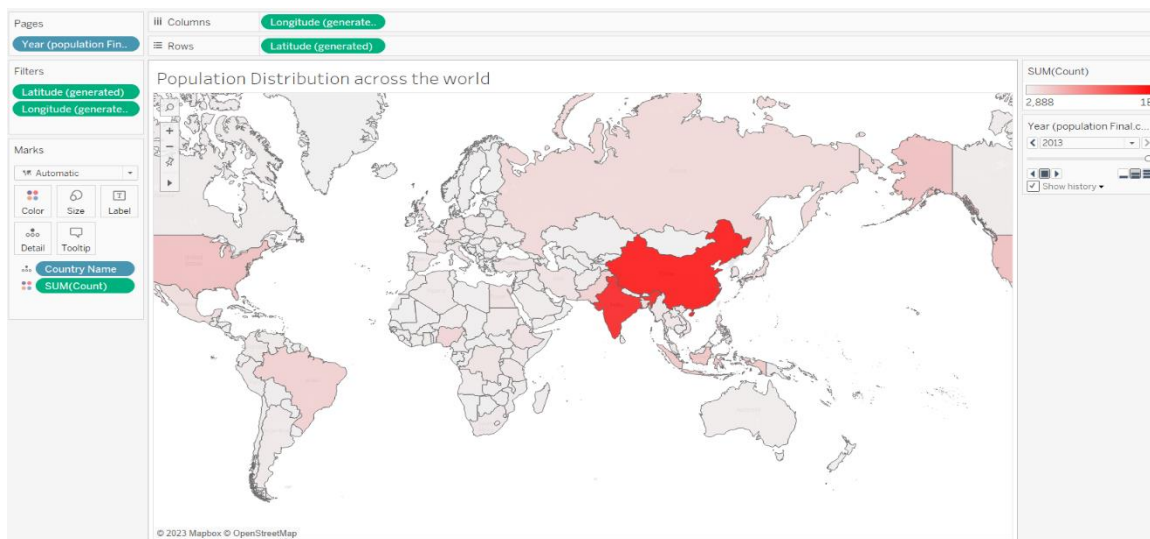
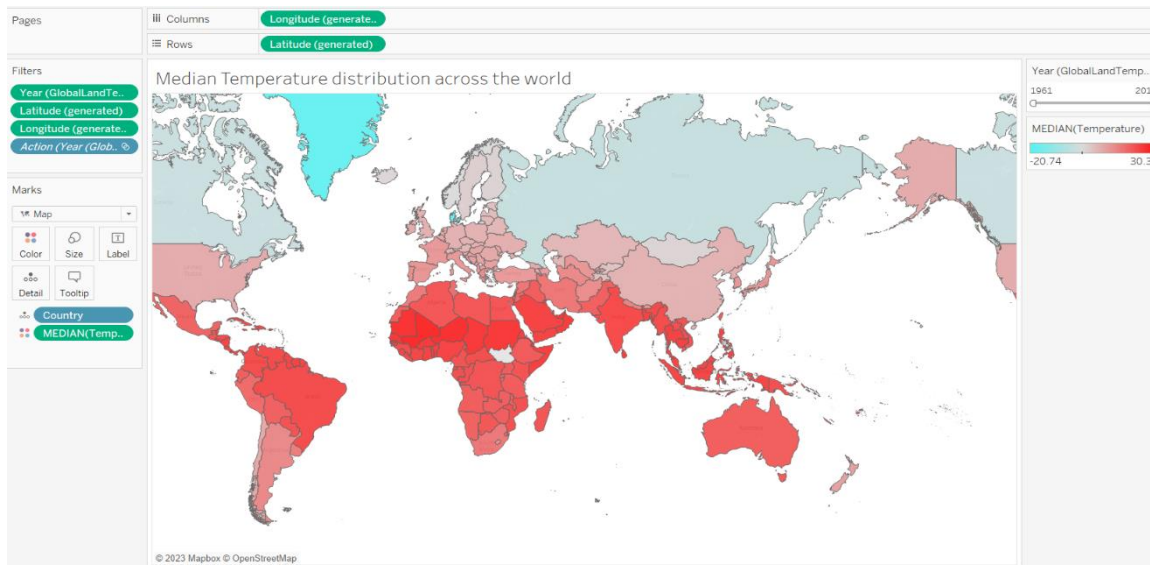


This dashboard suggests a correlation between the increase in population, average temperature, and average CO2 concentrations. The rising global population has led to an increase in energy consumption, which has resulted in higher emissions of greenhouse gases such as carbon dioxide.

These emissions, in turn, have contributed to the phenomenon known as global warming, which causes a steady rise in the earth's average temperature over time. As the temperature increases, it can lead to various negative impacts on the environment and human health.

Therefore, this dashboard serves as a reminder of the need for sustainable practices and policies to reduce our carbon footprint, mitigate the effects of climate change, and protect the planet for future generations.

After checking this, I was curious to find out how was the median global temperature and total population distributed across the world and the results are given below:

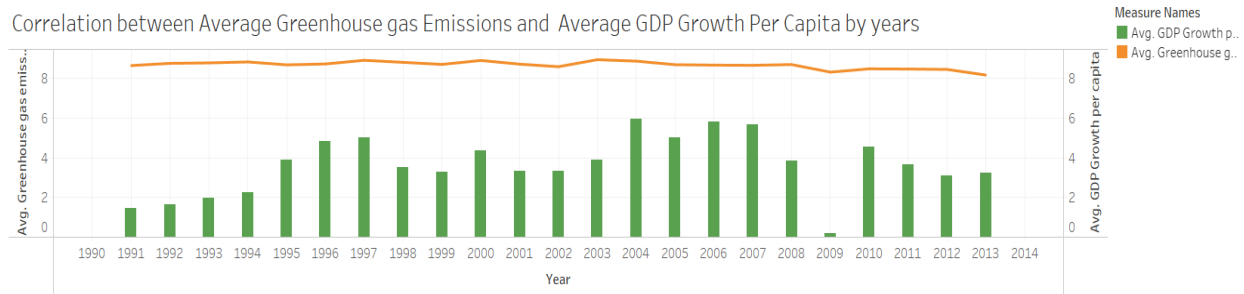


- Is there a correlation between the levels of greenhouse gas emissions and the growth of GDP in different countries over the years, Top GHG emitters and Average GHG to GDP Ratio by Countries and Years?

Solution:

Global Climate Change: Exploring the Correlation Between GDP Growth and Greenhouse Gas Emissions, Top Emitters, and Average GHG to GDP Ratio by Countries and Years.

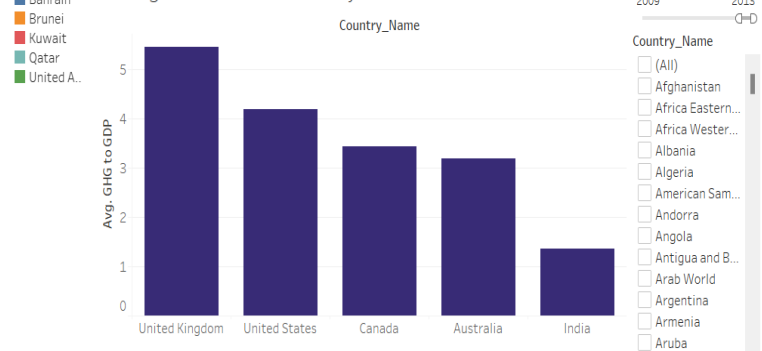
Correlation between Average Greenhouse gas Emissions and Average GDP Growth Per Capita by years



Top Countries with highest Greenhouse gas Emissions



Average GHG to GDP Ratio by Countries and Years



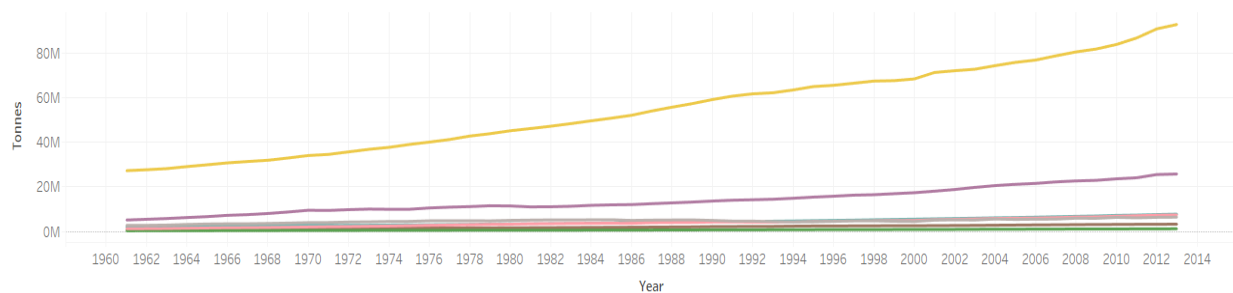
The relationship between GDP growth and greenhouse gas emissions suggests that economic development and environmental sustainability are often at odds, as many of the factors driving economic growth (e.g., industrialization, transportation, energy use) also tend to increase greenhouse gas emissions. The fact that the top greenhouse gas emitters are wealthy countries in the Middle East (Qatar, Bahrain, Brunei, UAE, Kuwait) suggests that the link between economic development and emissions may be particularly strong in countries that rely heavily on fossil fuel extraction and export. Finally, the variation in the average greenhouse gas to GDP ratio across different countries and years highlights the importance of policy and technological solutions that can help decouple economic growth from environmental harm.

- How do variations in the types and amounts of air pollutants emitted by different countries over time relate to differences in per capita emissions and the health impacts of air pollution worldwide?

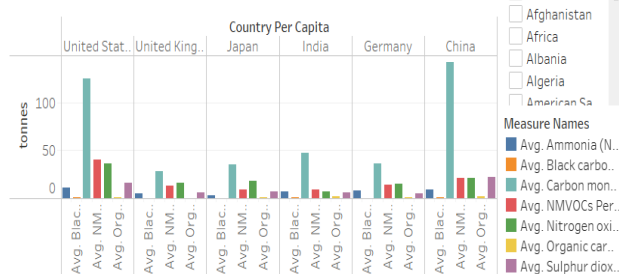
Solution:

Global Climate Change: Exploring the Relationship between Air Pollutants, Per Capita Emissions, and Global Health Impacts”

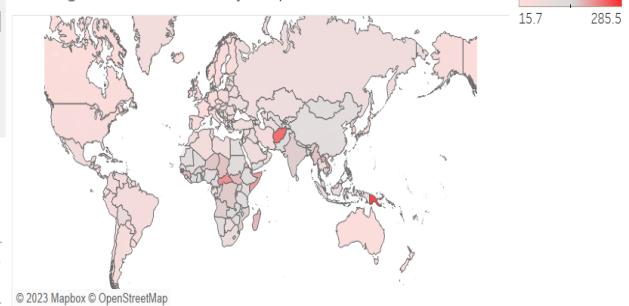
Various gases that contribute to air pollution by year



Average emission of different gases per capita by Countries



Average deaths caused by air pollution world wide



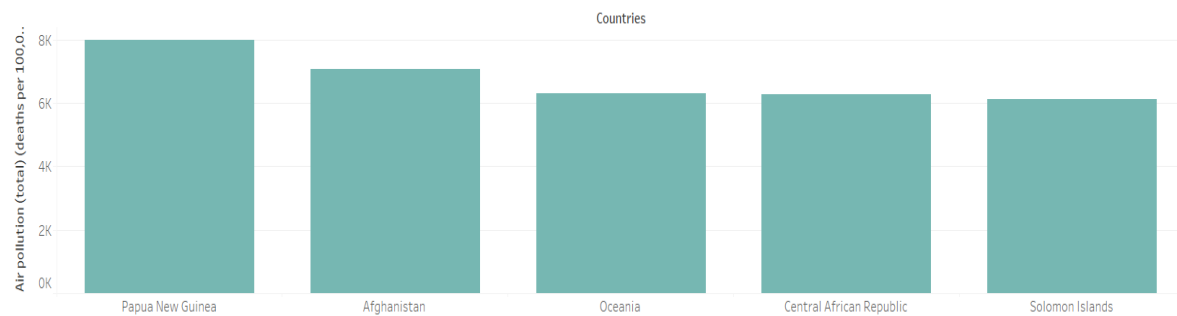
The dashboard provides a comprehensive view of air pollution and its impacts. It shows evidence of variations in the types and amounts of air pollutants emitted by different countries over time, which result in differences in per capita emissions and health impacts worldwide. The information presented can inform policy decisions aimed at reducing the most harmful pollutants and countries that contribute the most to global air pollution. Additionally, the dashboard highlights the human impact of air pollution and provides insights into the relationship between variations in air pollutants, per capita emissions, and health impacts.

4. What are the impacts of indoor and outdoor air pollution on human health and which countries are most affected by air pollution-related deaths?

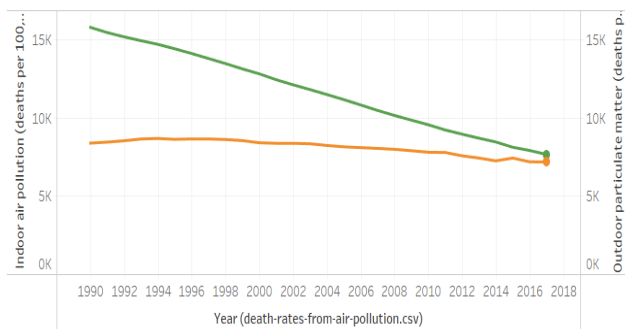
Solution:

Global Climate Change: Comparing Total Deaths due to Air Pollution, Yearly Trends, and Top Countries

Top countries by total deaths due to air pollution



Average deaths per year due to indoor and outdoor air pollution



Top countries by average deaths due to indoor and outdoor Air pollution

Countries	Avg. Indoor air po.. Avg. Outdoor par..	
Papua New Guinea	258.7	26.7
Afghanistan..	204.0	46.0
Solomon Islands	199.8	18.8
India		

The dashboard provides insights into the impacts of indoor and outdoor air pollution on human health and identifies the countries that are most affected by air pollution-related deaths. The first visualization shows the top countries by total deaths due to air pollution, highlighting the severity of the issue and the need for action to reduce air pollution. The second visualization shows that while the average deaths per year due to indoor and outdoor air pollution have reduced over the years, the problem persists and remains a significant public health concern. The third visualization identifies the top countries by average deaths due to indoor and outdoor air pollution, emphasizing the need for targeted interventions to reduce the negative impact of air pollution on human health in these countries. Overall, this dashboard provides important information that can inform policy decisions

aimed at reducing the negative impact of air pollution on human health, particularly in the countries that are most affected.

CONCLUSION:

This project provides valuable insights into the trends, correlations, and impacts of global climate change. It highlights the link between the increase in population, energy consumption, and greenhouse gas emissions, leading to rising temperatures and negative impacts on the environment and human health. The relationship between economic growth and emissions suggests the need for sustainable policies and technological solutions to decouple economic development from environmental harm. The comprehensive view of air pollution and its impacts emphasizes the severity of the issue, the need for action to reduce harmful pollutants, and targeted interventions to reduce the negative impact of air pollution on human health in the most affected countries.

The additional research questions that I have identified are:

1. How have land use and deforestation changed through time, and how has it affected CO₂ emissions?
2. How has precipitation and ocean acidification changed over the years due to rise in temperatures?
3. What is the impact of climate change on global migration patterns?
4. How do natural disasters such as hurricanes, tornadoes, and wildfires relate to climate change?

Overall, this project serves as a reminder of the urgent need for sustainable practices and policies to mitigate the effects of climate change and protect the planet for future generations.

THANK YOU