Carbon Dioxide Emissions and Mean Sea Level Pressure Analysis

1. Introduction:

Climate change is a real phenomenon whose impacts are felt in the natural environment and people's lives. Analyzing trends in carbon dioxide emissions and mean sea level pressure is crucial to develop risk management strategies adequately. This report aims to investigate the historical trends of carbon dioxide emissions in Europe from 1850 to 2022, the changes in global mean sea level pressure (MSLP) over time (1951-2021), and the interactions between these variables and rising temperatures.

2. Used Data:

Dataset	License	Years	Format	Unit	Source
Data source 1	CC BY 4.0	1850 - 2022	CSV	Milliontonnes (Mt)	Our World in Data
Data source 2	CC BY 4.0	1951 - 2021	TXT	hPa (Hectopascals)	Deutscher Wetterdienst

2.1. Pipeline Results:

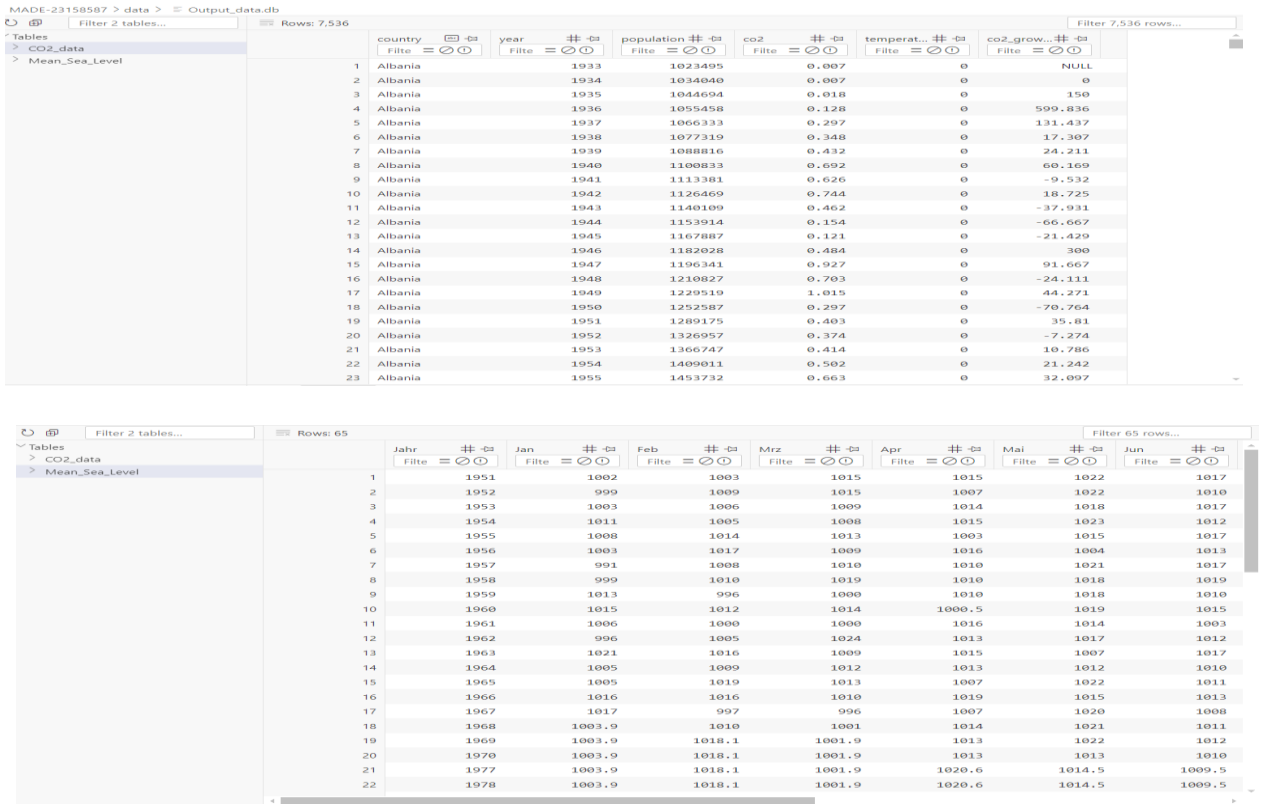

Figure 1: Local SQLite databases

3.1 What are the historical trends in carbon dioxide emissions in Europe from 1850 to 2022?

The report uses many Python libraries like pandas, mathplotlib, seaborn, sklearn, numpy, etc. for visualizing and finding correlations between two datasets. Jupyter Notebook which is a web-based interactive computing platform is used as a tool for visualizing the report. To analyze the historical trends in carbon dioxide emissions in Europe from 1850 to 2022, a comprehensive structure is followed. At first, we will examine the Carbon dioxide (CO_2) emission in Europe from 1850 to 2022 and its impact on Temperature increase, and later will find the sectors that contribute to increasing CO_2 emissions mostly**. Figure 2** shows that from the year 1850 to 1950 CO_2 emissions were relatively low and increased gradually. The period from 1975 to 2000 saw a sharp increase in emissions reaching approximately 8000 million tonnes by around 1990. Finally, from 2000 to 2022, emissions showed a declining trend after peaking around 2005. **Figure 3** shows the correlation coefficient between CO2 emissions and temperature change from CO2 is approximately 0.90. This indicates a very strong positive correlation, suggesting that as CO2 emissions increase, the temperature change from CO2 also increases.

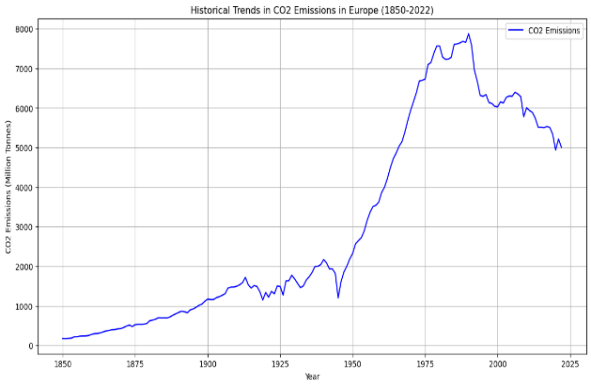

Figure 2: Historical Trends in CO_2 Emissions in Europe (1850-2022)

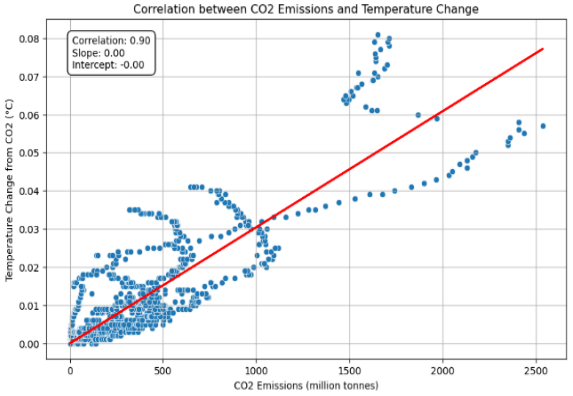

Figure 3: Correlation between CO_2 Emissions and Temperature Change

After that, we will try to find out which Countries and Sectors are highly responsible for emitting CO_2 in Europe.

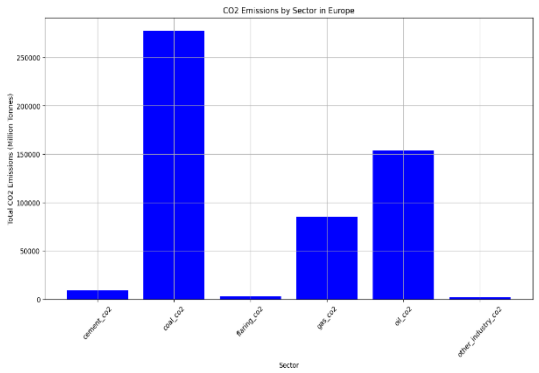

Figure 4: CO_2 Emissions by Sector in Europe

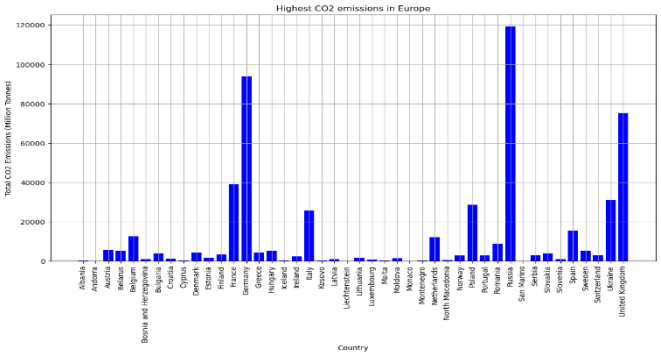

Figure 5: Highest CO_2 emissions by Country in Europe

Figure 4: Represents a detailed analysis of CO_2 emissions by sector in Europe. It reveals that the coal sector is the leading contributor, emitting around 250,000 million tonnes, overshadowing other sectors. The gas and oil sectors also have significant emissions but are notably lower than coal. In stark contrast, the cement, flaring, and other industry sectors contribute minimally to the overall CO_2 emissions. On the other hand, **Figure 5:** Shows a comparative perspective of CO_2 emissions by country in Europe. Russia emerges as the highest emitter, surpassing 100,000 million tonnes, followed closely by Germany. The United Kingdom and Ukraine also show substantial emissions, indicating their significant roles in the continent's overall CO_2 output. Meanwhile, many smaller countries exhibit negligible emissions, highlighting a disparity in CO_2 contributions across Europe.

3.2 How has the mean sea level pressure changed globally over time?

To address the question of how sea level pressure changes globally, some notable analyses have been done.

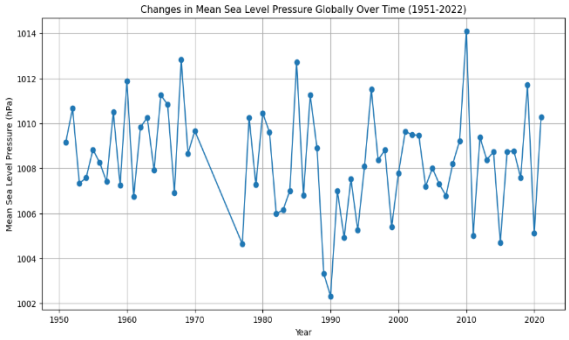

Figure 6: Changes in Mean Sea Level Pressure Globally Over Time (1951-2022)

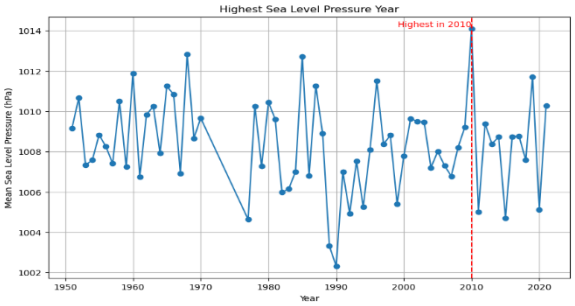

Figure 7: Highest Sea Level Pressure Year

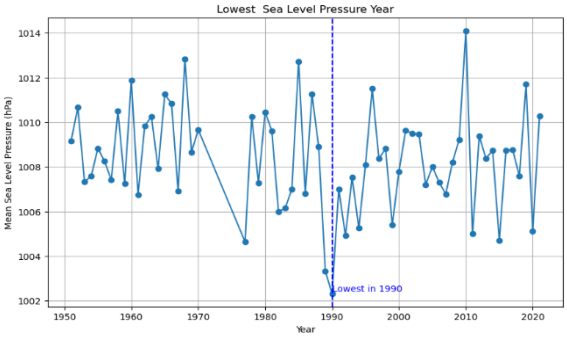

Figure 8: Lowest Sea Level Pressure Year

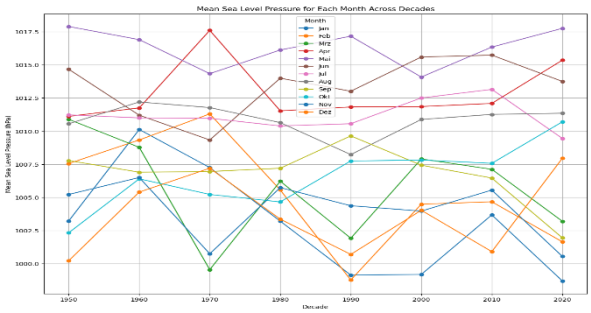

Figure 9: Mean Sea Level Pressure for Each Month Across Decades

Figure 6 presents a comprehensive view of the variations in global mean sea level pressure (MSLP) over 71 years. The data show multiple peaks and troughs, indicating periods of higher and lower pressures. **Figure 7** highlights the year with the highest recorded MSLP, which occurred in 2010 and **Figure 8** identifies 1990 as the year with the lowest recorded MSLP. **Figure 9** provides a detailed breakdown of MSLP changes for each month across different decades. Each line represents a specific month, showing how the mean pressure for that month has evolved. The graph reveals distinct patterns for each month, with some months like January and December consistently showing higher pressures, while others, such as August and September, display more variability.

3.3 How do CO_2 emissions and the increasing temperature make an impact on sea level pressure?

We will use a confusion matrix to analyze how sea level pressure correlates with CO_2 emissions and temperature increases.

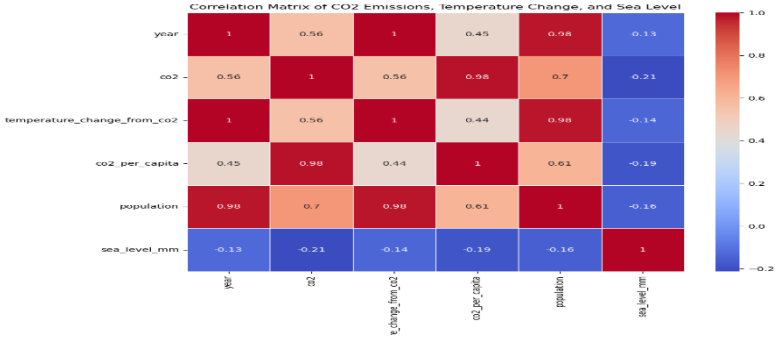

Figure 10: Correlation Matrix of CO2 Emissions, Temperature Change, and Sea Level

In the correlation matrix (**Figure 10**), there are strong positive coefficients between CO_2 emissions, changes in temperature, and sea level. The positive correlation is evident between the year and both temperature variations from CO_2, which stands at 1. 0, and population at 0. 98, meaning that both have been rising with time. CO_2 emissions are strongly related to CO_2 per capita with a coefficient of 0. 98, which indicates the effect of population increase on emissions. On the other hand, sea level possesses negative and insignificant correlations with all the other variables, which means that the relationship between them is intricate. In summary, the matrix demonstrates that an increase in the level of CO_2 emissions and population affects temperature change, while the link between the two variables and sea level change is more complex.

4. Conclusion:

The analysis report is dedicated to the historical perspective of carbon dioxide emissions in Europe for the period between 1850 and 2022 and their relation to temperature and sea level pressure fluctuations. This pattern of CO_2 emissions was relatively stable from 1850-1950, rose rapidly to 2000 and fell after 2005. The results of the correlation analysis indicated the existence of a high positive relationship between CO_2 emissions and temperature change, r = 0. 90. On a sectorial basis, the coal industry was the most emitting industry followed by gas and oil industries; Russia and Germany were the most emitting nations. Mean sea level pressure has increased year by year and month by month from 1951 to 2022 all over the world. However, sea level rise showed low coefficients of determination with CO_2 emissions, temperature changes, and population.

4.1. Limitations:

The correlation matrix highlights the limitations in understanding sea level rise, as indicated by its weak negative correlations with other variables: -0.13 with the year, -0.21 with CO_2 emissions, -0.14 with temperature change from CO_2, -0.19 with CO_2 per capita, and -0.16 with population. These weak correlations suggest that sea level rise is influenced additional factors. This complexity requires a broader range of data to fully understand its causes.