

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	Form at	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:

MADE-23158587 > data > Output_data.db

Filter 2 tables... Rows: 7,536

Tables

- CO2_data
- Mean_Sea_Level

	country	year	population	co2	temperat...	co2_grow...
	Filter	Filter	Filter	Filter	Filter	Filter
1	Albania	1933	1023495	0.007	0	NULL
2	Albania	1934	1034040	0.007	0	0
3	Albania	1935	1044694	0.018	0	150
4	Albania	1936	1055458	0.128	0	599.836
5	Albania	1937	1066333	0.297	0	131.437
6	Albania	1938	1077319	0.348	0	17.307
7	Albania	1939	1088816	0.432	0	24.211
8	Albania	1940	1100833	0.692	0	60.169
9	Albania	1941	1113381	0.626	0	-9.532
10	Albania	1942	1126469	0.744	0	18.725
11	Albania	1943	1140109	0.462	0	-37.931
12	Albania	1944	1153914	0.154	0	-66.667
13	Albania	1945	1167887	0.121	0	-21.429
14	Albania	1946	1182028	0.484	0	300
15	Albania	1947	1196341	0.927	0	91.667
16	Albania	1948	1210827	0.703	0	-24.111
17	Albania	1949	1229519	1.015	0	44.271
18	Albania	1950	1252587	0.297	0	-70.764
19	Albania	1951	1289175	0.403	0	35.81
20	Albania	1952	1326957	0.374	0	-7.274
21	Albania	1953	1366747	0.414	0	10.786
22	Albania	1954	1409011	0.502	0	21.242
23	Albania	1955	1453732	0.663	0	32.097

Filter 7,536 rows...

Tables

- CO2_data
- Mean_Sea_Level

	Jahr	Jan	Feb	Mrz	Apr	Mai	Jun
	Filter	Filter	Filter	Filter	Filter	Filter	Filter
1	1951	1002	1003	1015	1015	1022	1017
2	1952	999	1009	1015	1007	1022	1010
3	1953	1003	1006	1009	1014	1018	1017
4	1954	1011	1005	1008	1015	1023	1012
5	1955	1008	1014	1013	1003	1015	1017
6	1956	1003	1017	1009	1016	1004	1013
7	1957	991	1008	1010	1010	1021	1017
8	1958	999	1010	1019	1010	1018	1019
9	1959	1013	996	1000	1010	1018	1010
10	1960	1015	1012	1014	1000.5	1019	1015
11	1961	1006	1000	1000	1016	1014	1003
12	1962	996	1005	1024	1013	1017	1012
13	1963	1021	1016	1009	1015	1007	1017
14	1964	1005	1009	1012	1013	1012	1010
15	1965	1005	1019	1013	1007	1022	1011
16	1966	1016	1016	1010	1019	1015	1013
17	1967	1017	997	996	1007	1020	1008
18	1968	1003.9	1010	1001	1014	1021	1011
19	1969	1003.9	1018.1	1001.9	1013	1022	1012
20	1970	1003.9	1018.1	1001.9	1013	1013	1010
21	1977	1003.9	1018.1	1001.9	1020.6	1014.5	1009.5
22	1978	1003.9	1018.1	1001.9	1020.6	1014.5	1009.5

Filter 65 rows...

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, matplotlib, 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 (CO₂) emission in Europe from 1850 to 2022 and its impact on Temperature increase, and later will find the sectors that contribute to increasing CO₂ emissions mostly. **Figure 2** shows that from the year 1850 to 1950 CO₂ 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.

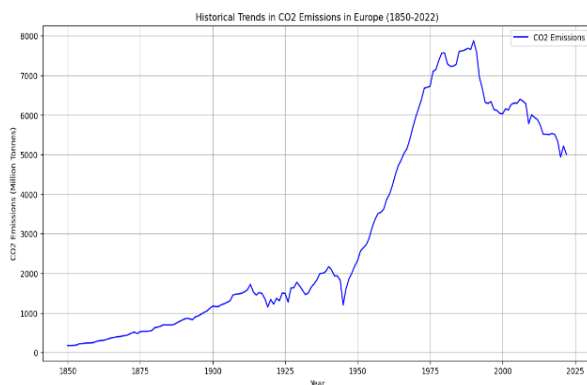


Figure 2: Historical Trends in CO₂ Emissions in Europe (1850-2022)

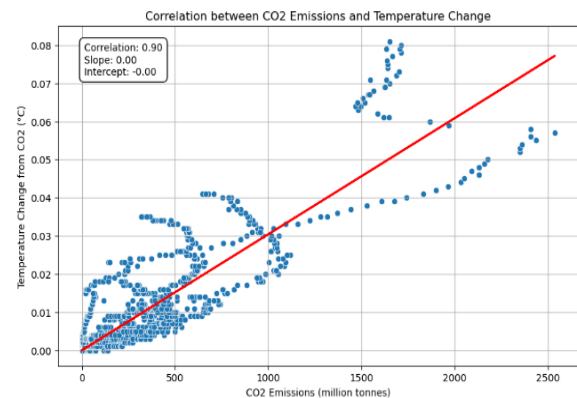


Figure 3: Correlation between CO₂ Emissions and Temperature Change

After that, we will try to find out which Countries and Sectors are highly responsible for emitting CO₂ in Europe.

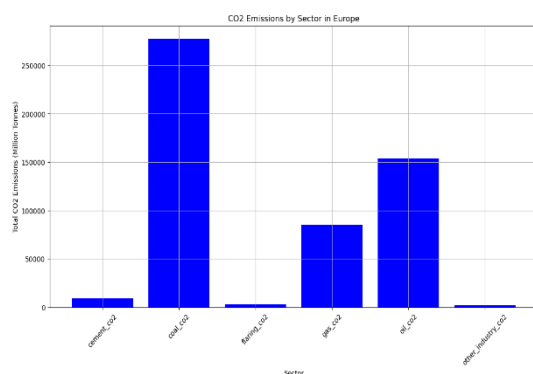


Figure 4: CO₂ Emissions by Sector in Europe

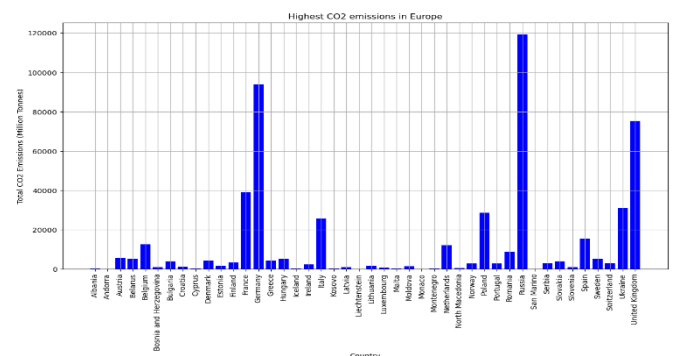


Figure 5: Highest CO₂ emissions by Country in Europe

Figure 4: Represents a detailed analysis of CO₂ 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 CO₂ emissions. On the other hand, **Figure 5:** Shows a comparative perspective of CO₂ 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 CO₂ output. Meanwhile, many smaller countries exhibit negligible emissions, highlighting a disparity in CO₂ 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.

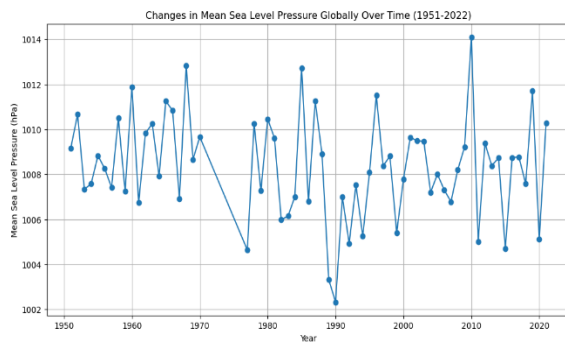


Figure 6: Changes in Mean Sea Level Pressure Globally Over Time (1951-2022)

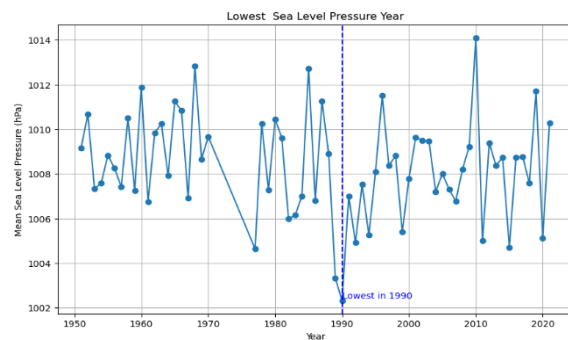


Figure 8: Lowest Sea Level Pressure Year

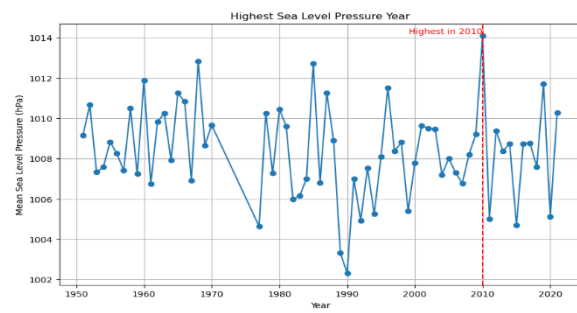


Figure 7: Highest Sea Level Pressure Year

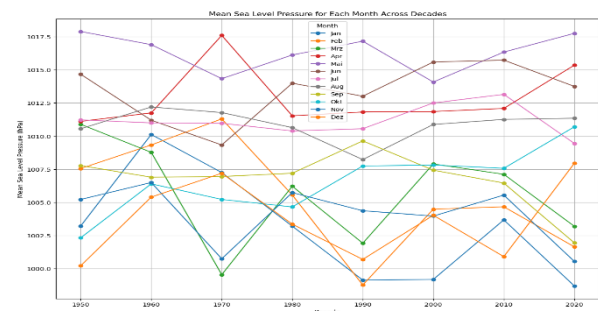


Figure 9: Mean Sea Level Pressure for Each Month Across Decades

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 CO₂ 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 CO₂ emissions and temperature increases.

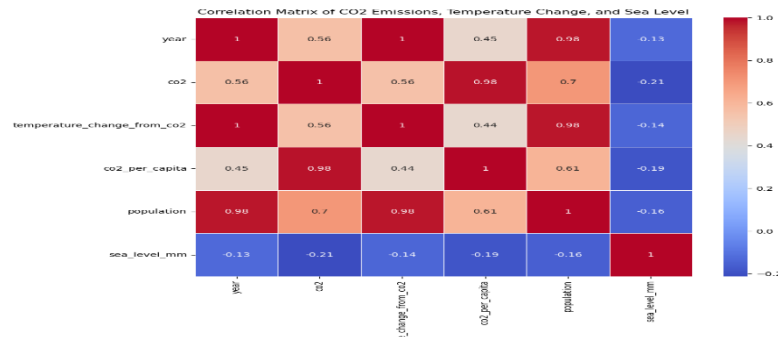


Figure 10: Correlation Matrix of CO₂ Emissions, Temperature Change, and Sea Level

In the correlation matrix (**Figure 10**), there are strong positive coefficients between CO₂ emissions, changes in temperature, and sea level. The positive correlation is evident between the year and both temperature variations from CO₂, which stands at 1.0, and population at 0.98, meaning that both have been rising with time. CO₂ emissions are strongly related to CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ emissions, -0.14 with temperature change from CO₂, -0.19 with CO₂ 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.