1 Analyzing the Impact of CO2 Emissions on Temperature Change

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1.2 Introduction

Climate change is a critical global issue because of its effect on the environment, human health, and economies. Through statistical analysis, this project investigates the relationship between temperature changes and CO2 emissions. The results are expected to examine the impact of CO2 emissions on temperature change. They may be used as information for future policy decisions related to greenhouse gas emissions. In this report, analysis are performed on following topics:

- How Have Temperature Changes and CO2 Emission Varied Over the Years?
- What is the Impact of CO2 Emissions on Temperature Change Globally?
- What is the Impact of CO2 Emissions on Temperature Change in Individual Countries?

1.3 Used Data

1.3.1 Data Source 1 : FAO Temperature Change

- **Why Chosen:** The dataset provides annual temperature change for various countries and it's from trustworthy source.
- **Source:** Food and Agriculture Organization (FAO)
- **Data Contains:** The FAOSTAT Temperature change on land domain disseminates statistics of mean surface temperature change by country.
- **Metadata URL:** FAO Temperature Change Metadata
- **Data URL:** FAO Temperature Change Data
- **Transformation steps on FAO Temperature Dataset:**
  - Only keeping the records where there is a temperature variation remove standard daviation category.
  - Eliminate not useful columns like "Area Code," "Area Code (M49)," "Element Code," "Months Code," "Unit," and "Element as these columns have no real purpose in the analysis"
  - Use `pd.melt()` to reshape the data from wide to long format as it will be useful to time series analysis.

1.3.2 Data Source 2: World Bank CO2 Emissions Dataset

- **Why Chosen:** This dataset offers extensive CO2 emissions data yearly for various countires

- **Source:** World Bank
- **Data Contains:** CO2 emissions data (in kilotons) for various countries.
- **Metadata URL:** World Bank CO2 Emissions Metadata
- **Data URL:** World Bank CO2 Emissions Data
- **Transformation steps on World Bank CO2 Data:**
  - Rename columns (such as "Country Name" to "Area") to maintain consistency between datasets.
  - Eliminate columns like "Indicator Code" and "Indicator Name as they they serve no usecase in our analysis"
  - Use `pd.melt()` to reshape the data from wide to long format useful for time series analysis.
  - Remove records where the CO2 emission numbers are absent.
  - Convert the 'year' and 'co2_emissions' data types to achive consistancy.

1.3.3 Pipeline Output :

[29]:
```
#display merged table results
```

[29]:

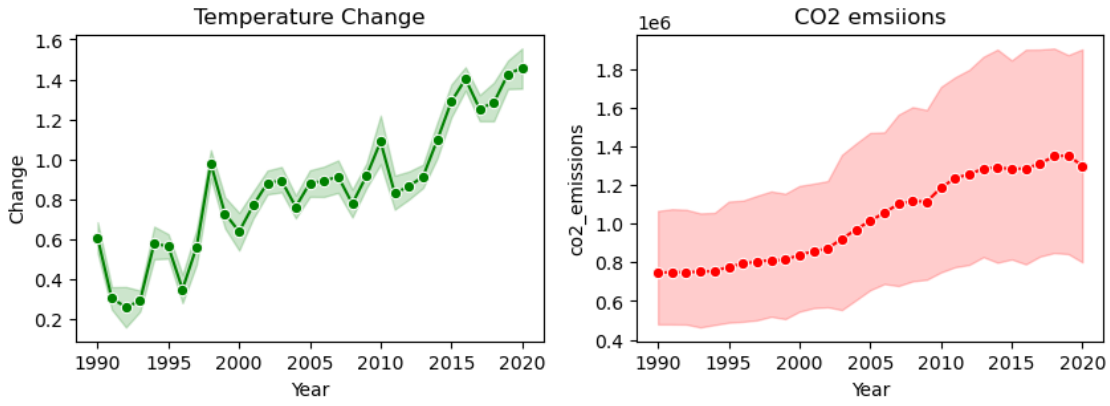
	Area	Year	Change	country_code	co2_emissions
0	Afghanistan	1990	0.714000	AFG	2046.87
1	Afghanistan	1991	0.138333	AFG	1941.37
2	Afghanistan	1992	-0.185917	AFG	1525.47
3	Afghanistan	1993	0.163000	AFG	1527.89
4	Afghanistan	1994	0.469667	AFG	1493.59

1.4 Analysis

1.4.1 Individual Analysis

Before analyzing the correlation between temperature and CO2 it is important to analyze how these have varied over the year thus a line plot is used to represent both CO2 emissions and temperature change simultaneously. The line in each plot indicates the average (mean) value for each year, while the shaded area around the line represents the range of variability for each year, offering more insights.

[30]:
```
# Figure 1 : trends for Temperature change and CO2 emissions globally over the␣
↪year span
```

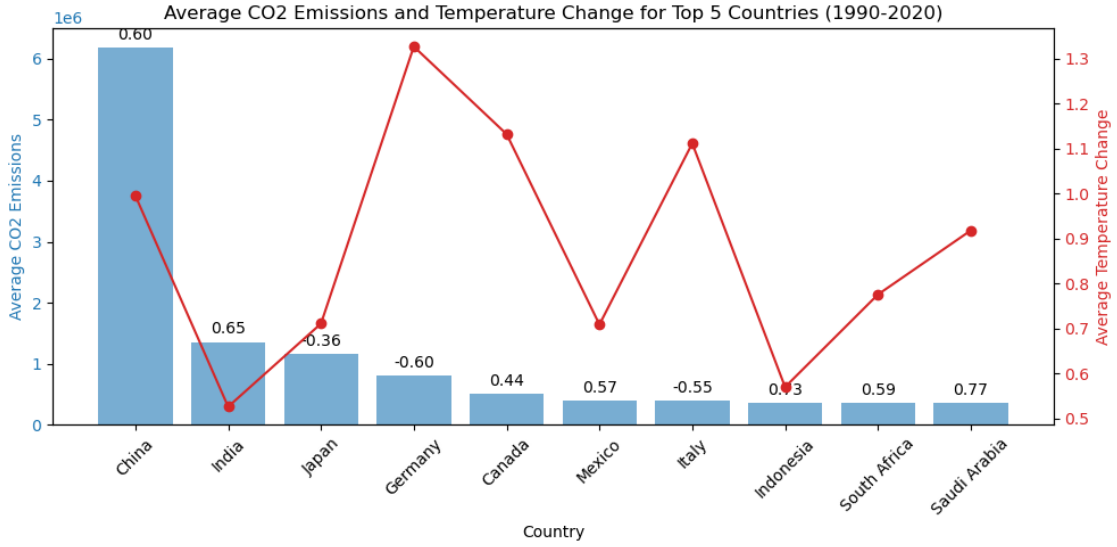


- There's been a noticeable increase in temperature over the recent years. This trend was foreseeable, as climate change gets more drastic.
- CO2 emission has shown a steady but constant upward trend
- As CO2 emissions have increased, there has been a corresponding increase in global temperatures.

1.4.2 Correlation Analysis:

To examine the correlation relationship between CO2 emission and temperature change Pearson Correlation was used. The `Pearson Correlation` measured the linear relationship between CO2 emissions and temperature changes. The coefficient ranges from -1 to 1, stating a negative to positive correlation, respectively. A positive value indicates that as CO2 emission increases, so will the temperature change.

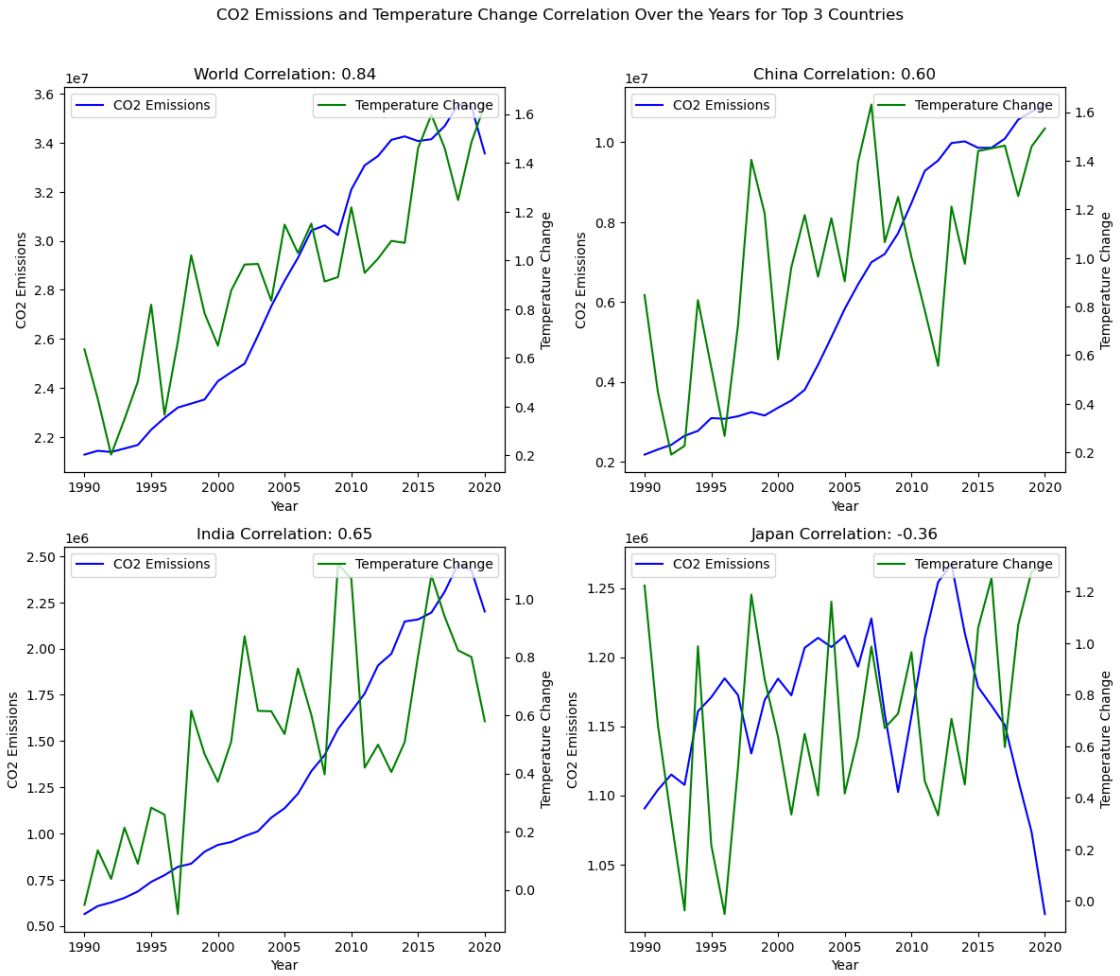
Figure 2: Bar Graph displaying Pearson Correlation for top 10 countries from Dataset



1.4.3 Country-Specific Analysis:

To delve into the specifics of how CO2 emissions correlate with temperature change on a Country-Specific basis, The dataset was segmented to each country included in the study. For each country, the trends were displayed using `line plots` and `Pearson's r correlation coefficient`. This approach allowed us to explore whether there is a notable correlation between temperature changes and CO2 emissions within individual countries.

[33]:
```
#Figure 3: Line plots showing country-specific relationship over the year span␣
↪(1990-2020)
```



- Global Analysis:
  - Correlation Coefficient: The global analysis displayed a significant positive correlation of 0.84 between CO2 emissions and temperature changes. This suggests that CO2 emissions has a role to play with global temperature change.
- Country-Specific Analysis:
  - Varying Degrees of Correlation: Some countries show a positive correlation while others

show a negative correlation but the values are significant enough to show that CO2 emissions impact the temperature change to some degree.

This finding supports the hypothesis that CO2 emissions are one of the major driver of global warming.

1.5 Conclusion

Based on the analysis it is evident that the correlation between CO2 emissions and temperature changes varies by country. Some countries show a strong positive correlation, suggesting that higher CO2 emissions are associated with significant temperature changes. In contrast, others show weak or no correlation, indicating that there might be other factors which influence temperature changes in those countries.

1.5.1 Limitations:

- **Linearity:** The study assumes a linear relationship between CO2 emissions and temperature thus the model does not account for most of the dynamics involved in climate change.
- **Quality of Data:** Different countries may have reported or documented data in inconsistent or using different measures, thus resulting in inconsistency in data.
- **Application and Use:** Dataset sources for non-commercial use limit the data from being used for commercial application ideas.

1.5.2 Future Outlook:

- **Other Factors:** Other greenhouse gases and factors, like deforestation and industrialization, would give more comprehensive insights into climate change.
- **Mitigate Emissions:** The report lays a foundation work to associate temperature rise to CO2 emissions, finding that necessary efforts are needed to mitigate emissions if climate change is going to be fought.