Analyzing the Correlation Between Temperature Changes and greenhouse gas emissions from different sources in Germany

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1. Introduction

It's important to understand how climate change and gas emission from different sources are related. My data science project looks at how temperature changes and gas emissions specifically CO2 interact in Germany. The goal is to learn things that can help government leaders make plans to reduce the negative impacts of climate change on the environment.

I will be examining how temperature changes and emissions have evolved over the years, focusing specifically on Germany. One of my primary areas of interest is the correlation between temperature fluctuations and different types of emissions within this region. This focus is driven by the need to understand how well these efforts are correlating with changes in temperature patterns and to provide actionable insights that can guide environmental policies in Germany.

In this report, I will explore the following key topics:

- How Have Temperature Changes and Emissions Varied Over the Years in Germany?
- How Are Temperature Changes Correlated with Emissions?

2. Used Data

Data Source 1: Food and Agriculture Organization (FAO)

I have selected the FAO Corporate Statistical Database as my primary data source for its extensive range of reliable and comprehensive statistical data. This source is particularly valuable due to its well-maintained records and robust reputation in the field.

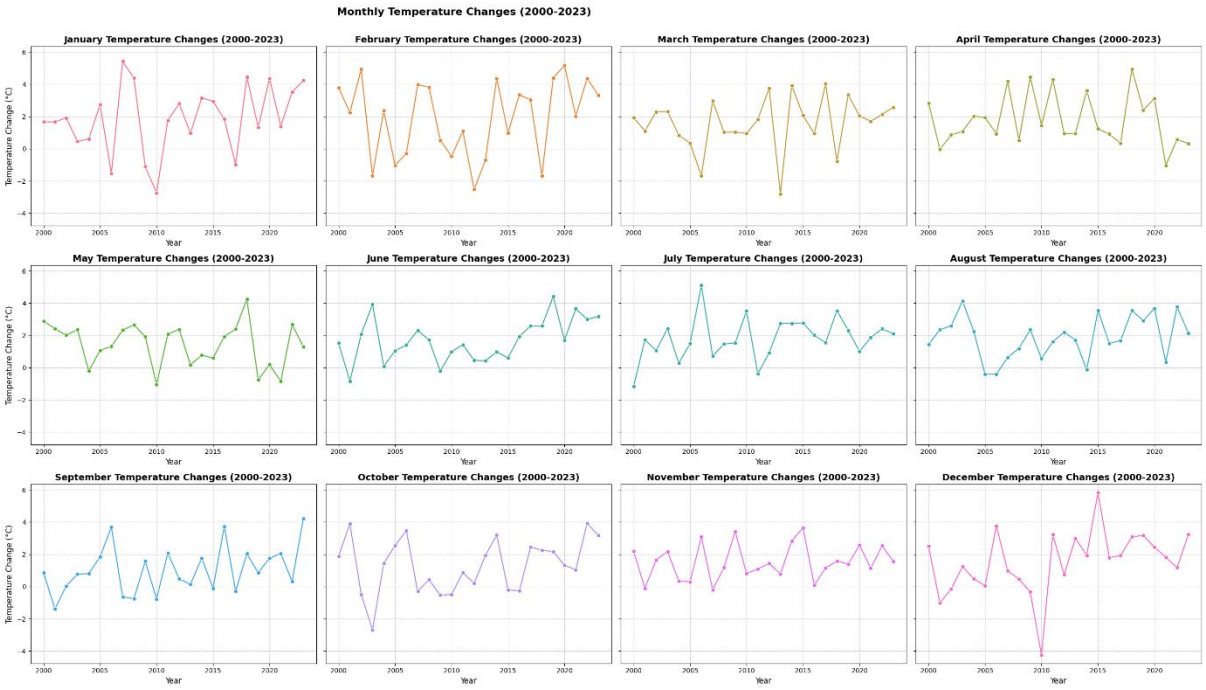
Metadata URL 1: FAO Statistics - Greenhouse Gas Emissions
Data URL 1: European GHG Emissions Data (CSV)
Data Type: CSV file containing yearly greenhouse gas emission data for European countries from 1961 to 2023.
License: CC BY-NC-SA 3.0 IGO
The FAOSTAT Emissions Totals domain offers detailed data on greenhouse gas emissions from agrifood systems, tracking emissions such as methane (CH4), nitrous oxide (N2O), carbon dioxide (CO2), and fluorinated gases (F-gases). This data adheres to the IPCC Tier 1 methodology and covers various economic sectors as outlined by the IPCC.

Data Source 2: Food and Agriculture Organization (FAO)

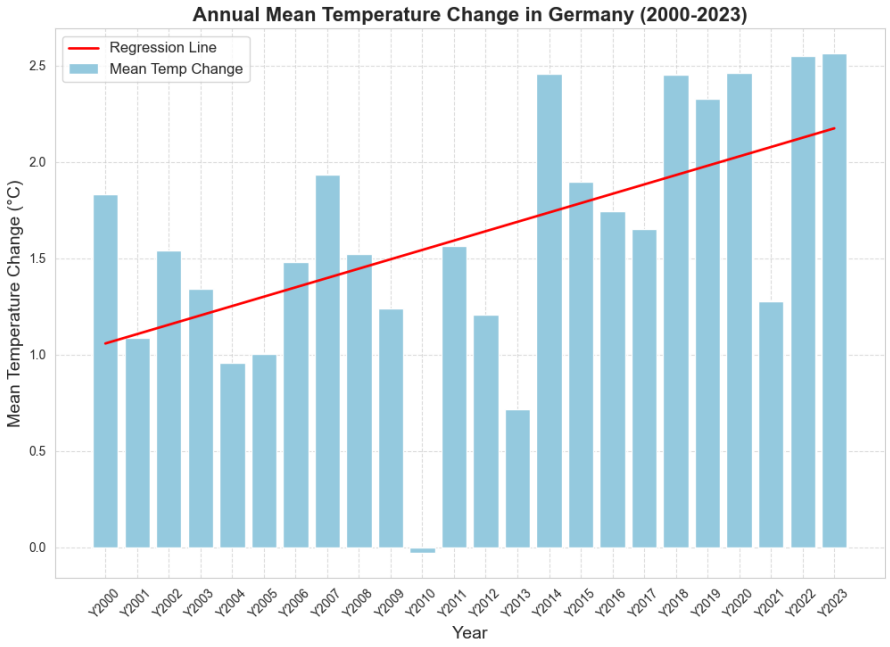
For temperature data, I have again chosen FAO due to their comprehensive environmental statistics.

Metadata URL 2: FAO Statistics - Temperature Change
Data URL 2: European Temperature Data (CSV)
Data Type: CSV file featuring FAOSTAT monthly temperature data for European countries.
License: CC BY-NC-SA 3.0 IGO
The FAOSTAT Temperature Change on Land domain provides statistics on mean surface temperature changes by country, updated annually. This dataset covers the period from 1961 to 2023 and includes monthly, seasonal, and annual mean temperature anomalies.

3. Analysis

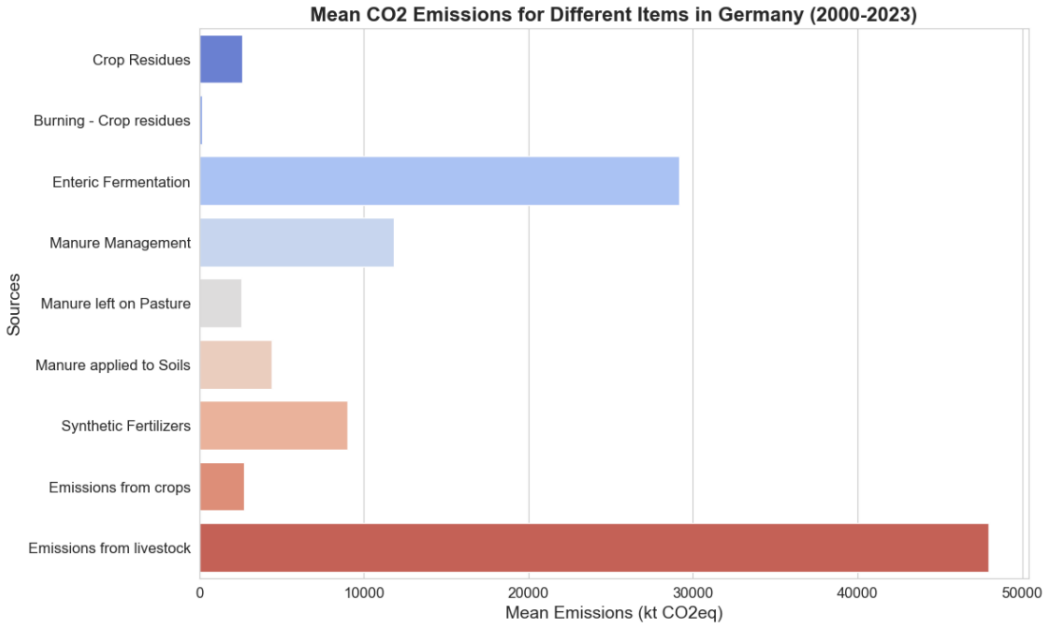


There is significant variability in temperature changes year over year for most months, with February and April showing pronounced fluctuations, while June and September exhibit more consistent trends. Noticeable warming trends are evident in certain months like September, whereas other months such as March and July show more stable temperature changes over the years. Seasonal patterns are evident, with winter months (December, January, February) showing more drastic temperature variations compared to some summer months (June, July, August).

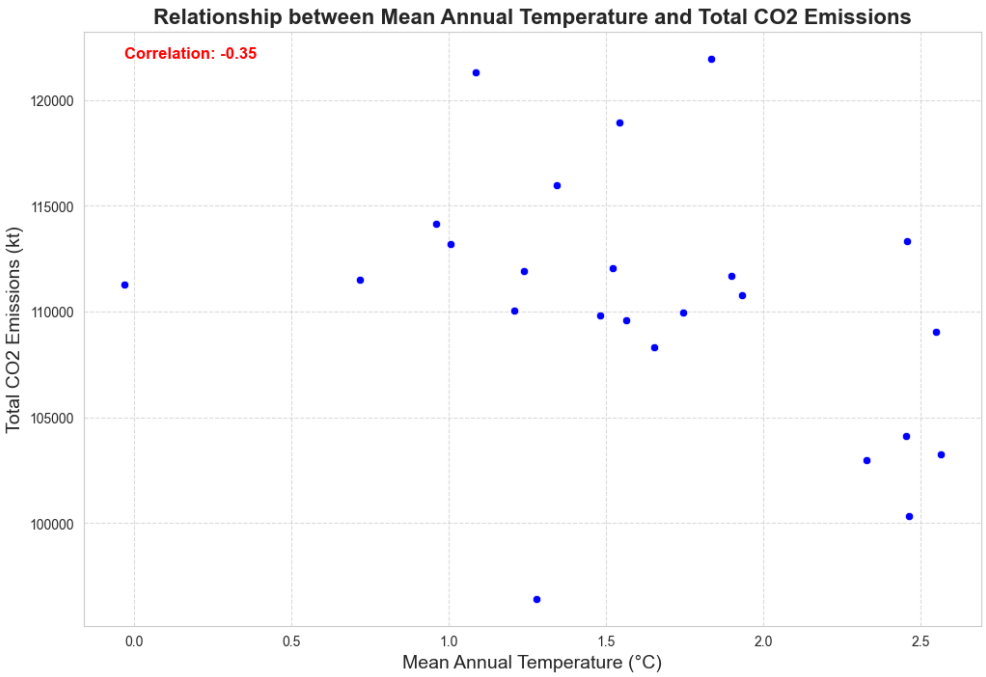


The above graph shows the annual mean temperature change in Germany from 2000 to 2023, represented by blue bars. Each bar indicates the change in mean temperature. The red trend line, derived

from a linear regression model, indicates an overall upward trend in mean temperature change over the observed period.



This graph represents the mean CO2 emissions from nine sources in Germany between 2000 and 2023. This visualization clearly differentiates the emission levels by source, providing an easy-to-understand comparison of which activities contribute most to Germany's agricultural CO2 emissions over the period. As you can see livestock has the highest emissions, followed by enteric fermentation. This can aid in identifying key areas for emission reduction efforts.



The scatter graph illustrates the relationship between mean annual temperature and total CO2 emissions from the year 2000 onwards. After calculating the yearly averages for temperature and the totals for CO2 emissions, I merged these two datasets on the year to create a combined dataset. The correlation coefficient calculated was -0.35, indicating a weak negative correlation, suggesting that as the mean

temperature slightly decreases, CO2 emissions tend to increase slightly, and vice versa. This analysis helps in visually understanding the impact of temperatures on emissions over the years.

4. Conclusions

- How Have Temperature Changes and Emissions Varied Over the Years in Germany?

Temperature changes in Germany have shown significant variability over the years, particularly in the winter months (December, January, February) which exhibit more drastic temperature variations compared to the summer months (June, July, August). Notably, February and April have pronounced fluctuations, while June and September demonstrate more consistent trends. An overall upward trend in mean temperature change from 2000 to 2023 is evident, indicating a general increase in temperatures over this period.

- How Are Temperature Changes Correlated with Emissions?

The correlation between temperature changes and emissions in Germany is weakly negative, with a correlation coefficient of -0.35. This suggests that as the mean temperature slightly decreases, CO2 emissions tend to increase slightly, and vice versa. This weak correlation implies that while there is some relationship between temperature changes and emissions, it is not strong enough to suggest that temperature changes alone are the primary driver of CO2 emissions. Other factors are likely contributing to the emission levels, necessitating a more comprehensive approach to understanding and mitigating greenhouse gas emissions.