Submitted by: Neha Navarkar

Global Greenhouse Gas Footprint

Visualizing Greenhouse Gas Emission Patterns Across Geographies

Objective

The project focuses on analyzing global agricultural emissions data, particularly emissions from cropland fires, to identify patterns and trends in greenhouse gas emissions. The goal is to provide visual insights into the emissions landscape and assess relationships between emissions and climate vulnerability.

Visualizations

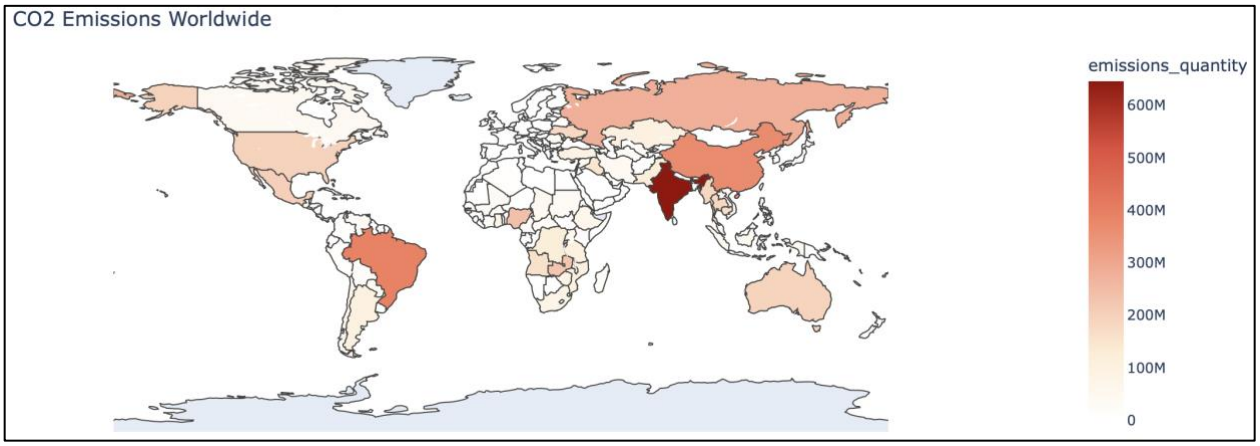

Fig 1. Exploring Global CO2 Emissions Across Countries since 2000

Fig 1 shows the map illustrates global CO2 emissions by country. The intensity of the color represents the total emissions quantity, with darker shades indicating higher emissions.
High Emissions Regions: Countries like India, China, and parts of South America demonstrate significantly high emissions, as indicated by the dark red areas. **Low Emissions Regions**: Many countries in Africa and smaller island nations exhibit lighter shades, indicating lower emissions quantities.

There is an Interactive map capturing co2 emission over the years.
(https://github.com/NehaSN23/greenhouse_gas_data_visualization/blob/main/Output/CO2_Emissions_Map.html)”

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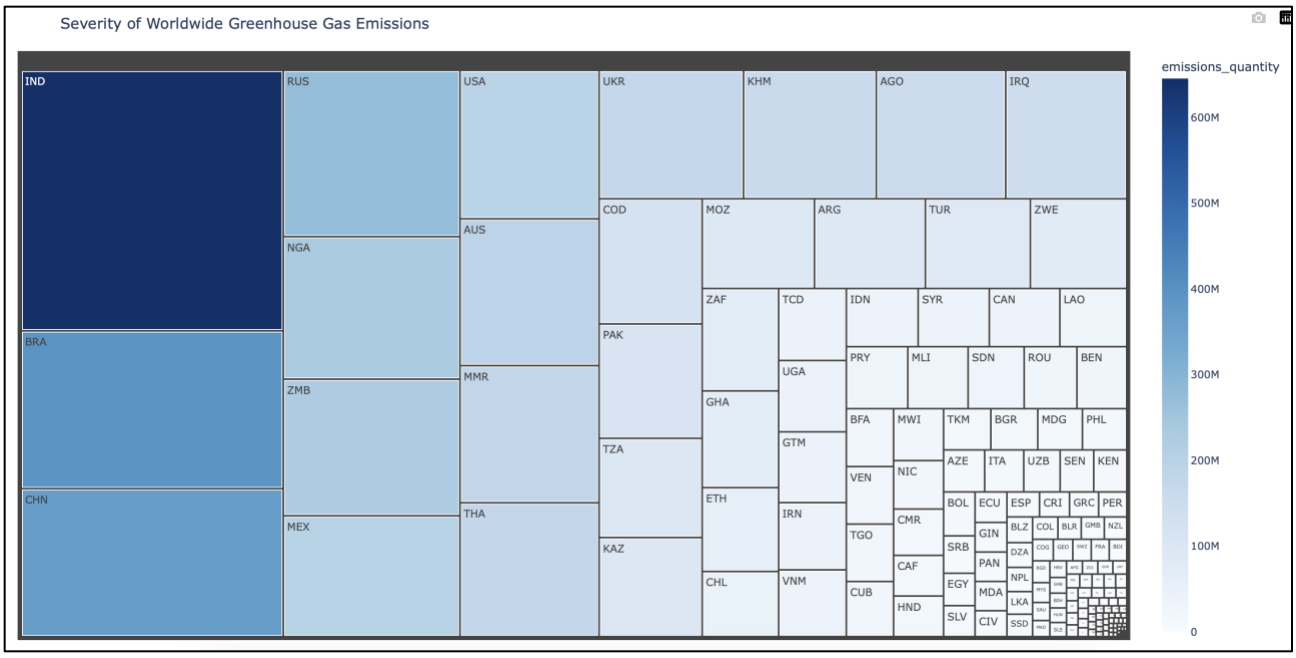

Fig 2. Greenhouse Gas Treemap

https://github.com/NehaSN23/greenhouse_gas_data_visualization/blob/main/Output/Greenhouse_Gas_Treemap.html

Fig 2 a interactive treemap, visualizes the severity of worldwide greenhouse gas emissions by country. Each rectangle represents a country, and its size corresponds to its emission quantity. The color intensity reflects emission levels, with darker shades indicating higher emissions. India (IND) and China (CHN) are the largest contributors, followed by Brazil (BRA) and Russia (RUS). These countries dominate the overall emissions landscape, as indicated by their larger and darker rectangles. **Regional Representation**: High-emission regions are more prominent in size and color, while smaller nations with lower emissions are represented by smaller and lighter rectangles. **Global Patterns**: The visualization emphasizes disparities in emissions, where a handful of countries contribute significantly compared to the majority.

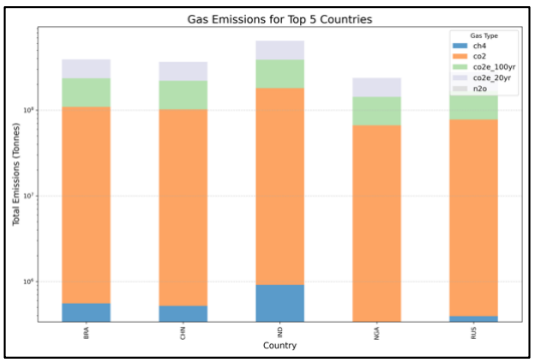

Fig 3. Gas emission for top five countries

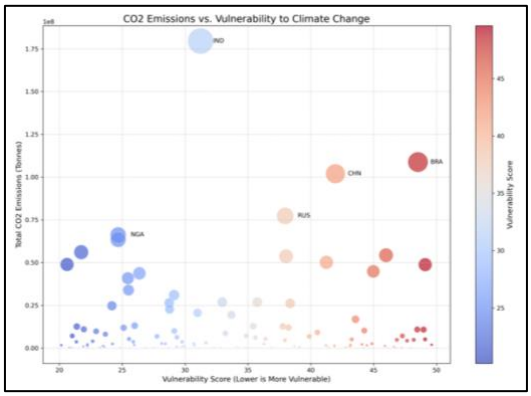

Fig 4. Co2 emission vs vulnerability to climate change

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Fig 3, is the stacked bar chart, it showcases the distribution of greenhouse gas emissions across the top 5 emitting countries. Each bar represents a country, while the segments indicate the contribution of various gas types, including CO2, CH4, N2O, and others. CO2 (orange) is the most significant contributor to total emissions for all countries, reflecting its predominant role in global greenhouse gas emissions. **Logarithmic Scaling**: The y-axis uses a logarithmic scale, enhancing the visibility of differences between gas contributions across countries.

Fig 4, the bubble chart illustrates the relationship between total CO2 emissions and countries' vulnerability scores. Bubble size represents the magnitude of CO2 emissions, while the color gradient highlights the vulnerability scores (lower scores indicate higher vulnerability to climate change). **High-Emission Nations**: India (IND), China (CHN), and Brazil (BRA) are prominent emitters, as represented by larger bubble sizes. These nations occupy varying positions on the vulnerability scale, suggesting that high emissions are not directly proportional to vulnerability.

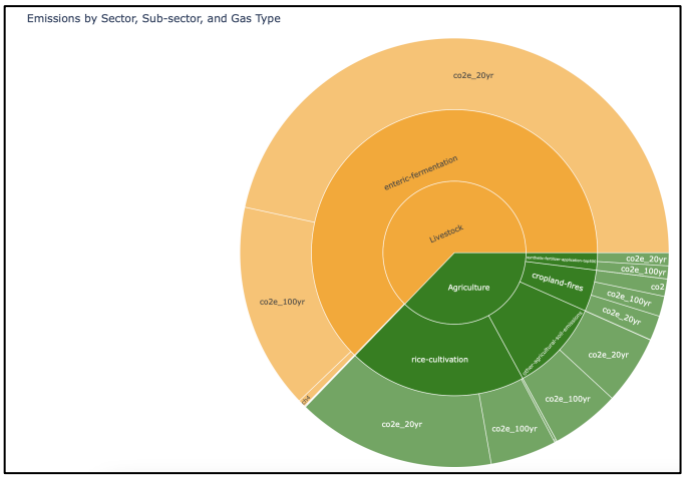

Fig 5. Surnbusrt chart

Fig 5, this sunburst chart illustrates the hierarchical breakdown of greenhouse gas emissions by sector, sub-sector, and gas type. It provides a comprehensive view of emissions distribution, with larger segments representing higher contributions. **Outer Rings**: Represent sub-sectors (e.g., rice cultivation, enteric fermentation). **Colors**: Different shades highlight gas types (e.g., CO2, CO2e). **Agriculture** and **Livestock** dominate emissions, particularly through sub-sectors like rice cultivation, cropland fires, and enteric fermentation. Sub-sectors are visually distinct, enabling quick identification of major emission sources within each category.

Importance

In this project, I have generated multiple visualizations. The selection was made to evaluate whether all the graphs effectively convey the same message and if the information illustrated in each aligns with the overall analysis. Exploring the data through different visual formats allows for a comprehensive understanding of the emissions landscape.
Each visualization format brings unique strengths and limitations:

- **Geographical Maps**: These maps vividly depict the physical location of emissions, making them ideal for identifying emission hotspots. However, they are less effective in showcasing the magnitude of emissions quantitatively.

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- **Scatter and Bubble Plots**: These graphs provide insights into relationships between variables, such as emissions and vulnerability, combining magnitude and comparative analysis. However, they lack geographical context.
- **Treemaps and Sunburst Charts**: These hierarchical charts excel in showing proportions and distributions across sectors and sub-sectors, making it easy to identify dominant contributors. They are, however, limited in representing temporal or spatial dynamics.
- **Stacked Bar Charts**: These visualizations clearly represent the contributions of various gas types across countries, making them effective for comparing compositions but less dynamic for exploring interdependencies.
- **Interactive Plots**: Interactive visualizations, like heatmaps and HTML-based maps, allow users to zoom in, explore details, and interact with data for a deeper understanding. Yet, they may lack the clarity of static graphs for quantitative analysis.

By combining these diverse visualization formats, the project provides a holistic perspective on greenhouse gas emissions globally. Each graph complements the others, ensuring a cohesive narrative that bridges geographical, hierarchical, and relational insights. This approach highlights the complexity of emissions data while enabling a clearer understanding of its distribution and impacts.

Data and Method

Data:

- The project utilizes a comprehensive greenhouse gas emissions dataset from Kaggle, focusing on emissions across sectors, sub-sectors, and gas types.
- Key variables include country identifiers, emission quantities, and vulnerability scores, providing both geographic and relational insights.

Method:

- **Data Processing**: The dataset was aggregated using Python libraries like Pandas and NumPy.
- **Visualization**: Tools like Matplotlib, Plotly were used to create static and interactive visualizations. Hierarchical charts (e.g., treemaps and sunburst charts) were generated to represent sectoral contributions.

Github Link:
https://github.com/NehaSN23/greenhouse_gas_data_visualization

Data Source:
https://www.kaggle.com/datasets/michaelbryantds/greenhouse-gas-emissions-dataset?select=agriculture

Source Code:
https://github.com/NehaSN23/greenhouse_gas_data_visualization/blob/main/SourceCode_v1.ipynb