CO2 Emissions and its consequences

Data visualization project

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Abstract

The report looks at the historical and contemporary patterns of CO2 emissions from both a global and regional perspective, analysing the links between emissions and social and economic factors. Using a series of data visualisations, the study analyses historical CO2 production trends among the world's major emitters, current emissions by country, and the relationship between per capita emissions and aspects of human development such as life expectancy, education and income within European regions.The results show complex and varied patterns of emissions over time, highlighting the difficulties of balancing economic growth with environmental sustainability. The visualisations provide valuable insights into the nuanced dynamics of emissions and offer guidance for targeted policies and sustainable practices.

1 Introduction

This research project examines the relationships between CO2 emissions, socioeconomic indicators, and historical trends with the objective of understanding the factors that contribute to environmental sustainability and economic prosperity over time. Data visualisations will be used to analyze the historical context, the global situation in the current years and the correlations between human development, economic growth, and their impact on the environment.

The study examines the relationship between CO2 emissions per capita and various components of the Human Development Index (HDI), including education, life expectancy, and income levels. The objective is to investigate the intricate connections between human development and environmental impact, considering historical and current perspectives.

What is the association between economic prosperity and environmental sustainability in European economies? This question examines the historical relationship between economic growth and environmental impact, providing insights that can inform policy and decision-making.

The inquiry investigates whether there are statistically significant correlations between life expectancy and CO2 emissions per capita among European countries, exploring the health impact of CO2 emissions in European nations both historically and currently.

Furthermore, this study analyses the historical trend of CO2 emissions among the world's leading emitters to comprehend the evolving dynamics of environmental responsibility. The research aims to provide insights to a diverse audience, including policymakers, environmentalists, and other stakeholders. The findings can help policymakers develop evidence-based environmental and economic policies, while environmentalists can use the analysis to promote sustainable practices. By demonstrating the links between CO2 emissions, human development and economic prosperity, we aim to support decision-making. We strive to encourage sustainable development and increase environmental awareness.

2 Data source

2.1 First Dataset

https://www.kaggle.com/datasets/toriqulstu/global-socio-economic-and-environmental-indicators This dataset provides a collection of socio-economic and environmental indicators for most countries across the world. Spanning the years from 1990 to 2021, the dataset includes valuable information on Human Development Index (HDI), Life Expectancy, Gross National Income per Capita (GNI), and CO2 Production.

Provenance: hdr.undp.org

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2.2 Second Dataset

https://github.com/owid/co2-data Complete CO2 and Greenhouse Gas Emissions dataset is a collection of key metrics maintained by Our World in Data. It is updated regularly and includes data on CO2 emissions (annual, per capita, cumulative and consumption-based).

3 Data preprocessing

3.1 Data Concatenation from Multiple Sources

Four distinct datasets were sourced from Kaggle and subsequently concatenated into a single comprehensive dataset. This consolidated dataset was then further combined with an additional dataset obtained from GitHub and specific data was added for the geographical analysis

3.2 Data Preprocessing and Feature Selection

We performed feture selection on the dataset considering the specific requirements for each dataset. Commonly selected features include 'year', 'co2', 'population', 'country', 'gnipc_', 'le_', 'hdi_', 'geometry', 'Region', 'Formal Name', 'co2_including_luc', and 'ISO3'. Identified features were chosen based on their relevance to the research questions and domain knowledge. Data corresponding to the year 2021 was exclusively extracted for further processing. Additionally, a check for missing values was performed, and it was

observed that the dataset did not contain any missing values. For European countries analysis, a list comprising exclusively European countries was created and applied to the dataset, resulting in a refined dataset for analyzing the distribution of CO2 emissions in European countries for the year 2021.

4 Data visualizations

4.1 Historical analysis: CO2 Production of Top Global Emitters

An area chart was used to track the CO2 production of the world's top global emitters over time. Each country is represented by a different color, making it easy to differentiate between them. The x-axis shows time, while the y-axis shows CO2 production, providing a clear temporal perspective on emissions trends. We used data visualization software to create this chart. It effectively shows the historical progression of CO2 emissions. Challenges we faced included normalizing the data and representing diverse emission scales. The visualization tells the story of how CO2 emissions have evolved among the world's leading emitters. It illustrates changes in emissions intensity and reveals patterns in responsibility for historical emissions.

4.2 Geographical analysis: World map of per capita and absolute CO2 emissions

The world maps illustrates CO2 emissions by country in 2021 using a colour-coded design. Darker colours indicate higher emissions, allowing an immediate visual assessment of the global distribution. We used mapping software to create this visualisation. The challenge was to accurately depict the distribution of emissions across countries and ensure that the map was intuitive for users. The reult show that the world map vividly depicts the current landscape of CO2 emissions, highlighting high emitting regions. It helps to identify regions with significant environmental impacts and serves as a valuable reference for policy and awareness-raising efforts.

4.3 Socio-economical analysis: CO2 emissions per capita, HDI and Life Expectancy index

In this section, bubble charts were used to visually correlate CO2 emissions per capita with components of the HDI (education, life expectancy and income levels). The size of the bubbles represents population size, while the colour distinguishes different regions. This design allows for multi-dimensional comparison. Development: We used data visualisation software to create these interactive charts, which allow users to explore the relationships between socio-economic factors and CO2 emissions. Challenges included ensuring that the visualisations accurately represented complex relationships. Results: These visualisations provide insights into the interplay between CO2 emissions and human development factors. They highlight differences between regions and suggest that economic prosperity does not always correlate with higher emissions.

5 Interface design

The website was designed with a minimalistic style to focus attention on the project's message. The visualizations are divided into three chapters: historical, geographical, and socio-economic. This approach helps the user understand when the problem arose, where it stems from, and who it affects. Pictures are used to separate different sections and to evoke empathy towards the problem and the people affected by it. Users can zoom in on specific data points, hover over bubbles for detailed information, and select countries on the world map for additional insights. The interface has been designed with accessibility in mind, ensuring that users can easily navigate and engage with the data to gain a deeper understanding of the relationships between CO2 emissions, human development, and historical trends.

6 Color palette

The colour palette follows a minimalistic approach as well, consisting of two main colours: black and orange. These colours are chosen to convey the message of CO2 production through the mental association with coal and fire. Later, the black parts were substituted with a dark shade of grey to

reduce visual strain, and different shades of orange were used where necessary. Most of the text is kept white for clarity.

7 Next steps

7.1 Temporal Analysis

- Expand historical analysis to include more years, revealing long-term trends and significant events.
- Explore how environmental indicators have evolved over time, allowing for a comprehensive understanding of historical patterns and potential factors influencing change.

7.2 Regional Variations

- Delve deeper into regional disparities within Europe to identify regions that are successfully balancing economic growth and environmental sustainability.
- Investigate the factors contributing to variations in environmental performance across different European regions.

7.3 Policy Impact Assessment

- Evaluate the effectiveness of environmental policies in different regions, assessing their impact on emissions while maintaining human development standards.
- Analyze the correlation between policy implementations and environmental outcomes, providing insights for policy refinement.

7.4 Additional Data Sources

- Incorporate data on renewable energy, energy efficiency, and policies to provide a more comprehensive view.

- Augment the existing dataset with relevant information to gain a holistic understanding of the interplay between environmental indicators and sustainable practices.

7.5 Comparative Studies

- Compare European data with other continents to identify global trends and best practices.
- Conduct cross-continental analyses to identify successful strategies, potential challenges, and opportunities for international collaboration on environmental initiatives.

7.6 Predictive Modelling

- Develop models to predict future emissions based on current conditions, enabling scenario analysis and informed policy planning.
- Use predictive analytics to anticipate potential environmental outcomes and assess the effectiveness of different intervention strategies.

7.7 Interdisciplinary Collaboration

- Work with experts in environmental science, economics, and public policy to gain deeper insights and holistic solutions to environmental challenges.
- Foster interdisciplinary collaboration to address complex environmental issues from multiple perspectives, promoting a more integrated and effective approach.