COM480-Data Visualization

Climate Visualization

DataDrift Dream Team

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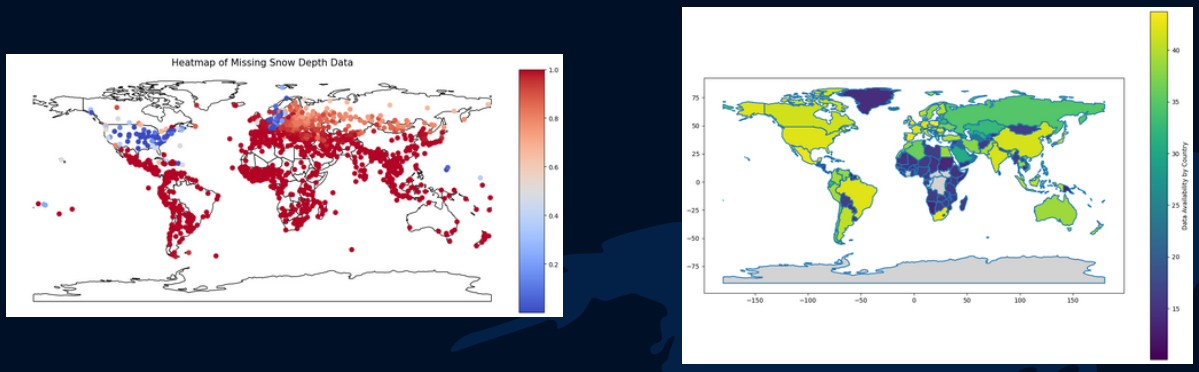
Introduction

Climate change is generally agreed upon to be one of the largest of the 21st century. If not addressed properly, the consequences can be catastrophic. Even though data on the topic is widely available and there has been a lot of research on the topic, there is still a large disagreement in society as to how large the problem actually is. Several scientists, politicians, and celebrities spoke out against the scale of global warming. To empower users to visualize the effects of climate change, we decided to create a tool that comprises multiple datasets and has been extended to view different metrics on climate, precipitation, and energy.

After searching through climate datasets and checking their time coverage and details, we found our main dataset: "Global Daily Climate Data" by Guillem Servera. This dataset includes a large collection of daily climate records, covering important metrics like temperature and precipitation over many decades. However, some values are missing.

To add more context to the visualization and show progress over the years, we decided to add energy consumption and population data. Curated by Pralabh Poudel, this dataset comprises global energy usage patterns and demographic transitions, encapsulating the intricate interplay between human activities and environmental impacts.



Visualizations from the exploratory data analysis

Combining these datasets, we have a lot of possible features and visualizations to create. We are not planning to make any future predictions and instead will show data up until now. Our visualizations aim to enable our users to draw their own conclusions on whether or not we are doing enough as a society to combat this global problem.

After finalizing the decision on the datasets, we started to think about what possible visualizations we could create. Since most of our data had a strong spatial aspect, we decided on a map. Even though, as mentioned in the lecture on maps, there are also alternatives to maps, we decided that it is the best option for our dataset.

However, we had too much data to visualize clearly on a global map. That is why we chose to also add a view for a specific country and show other statistics here. More on this later.

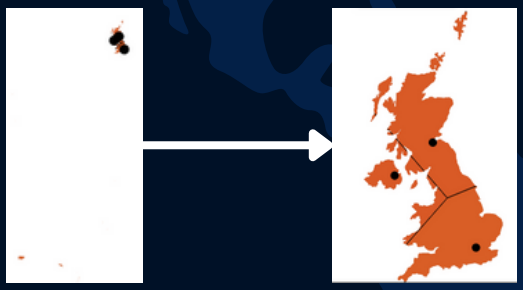
Challanges and design decisions

During the creation of this project, we faced several challenges. We made some particular design decisions but managed to overcome all the issues we faced within the scope of this project. The very first challenge that we faced was how to visualize the first page. Climate change is a very complex topic and we have a lot of data to display. In the end, we started with a Mercator worldview and progressively added features. Users are generally very familiar with this map, it's easy to understand and very intuitive. However, after the lecture on maps, we also saw the limitations of the Mercator map and wanted to add something more true to scale. That is why we decided to add a globe view for users to interact with. This way users can leverage the strengths of both maps.

Another challenge we overcame was the integration of the plots and metrics for the individual country pop-up window. The metrics here came from different places and sometimes had local spatiality which was very important. An average temperature does not make a lot of sense on a country-wide scale. This is why integrated a Voronoi diagram to find the closest measuring station for any point in a country, and attach this value.

A major issue we did not foresee but something we could have expected, is misalignment between different sources of data. The global world map is based on Natural Earth data, which is a public domain dataset that follows the 'facts on the ground', the 'de facto' boundaries. For the individual countries, however, we took a dataset based on UN border agreements. This meant that one global map sometimes contained countries that did not exist in the individual countries dataset. Northern Cyprus, Taiwan, Antarctica, and Greenland are examples of what the Natural Earth dataset classified as countries but the UN does not. Aligning these datasets was a large challenge. Furthermore, some countries have overseas territories that distort the view of the country. This is because now the bounding box of the country is very large, but most of what is inside this bounding box is water or other countries. We manually removed the overseas territories from the individual country view to fix this issue.

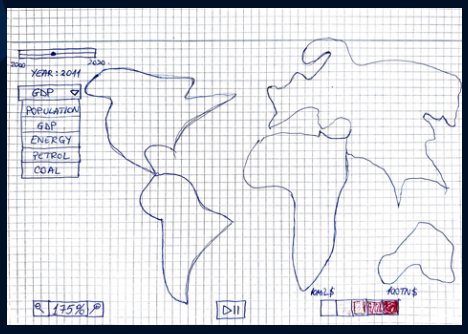
The UK view gets distorted because of their overseas territories (the Falkland Islands)

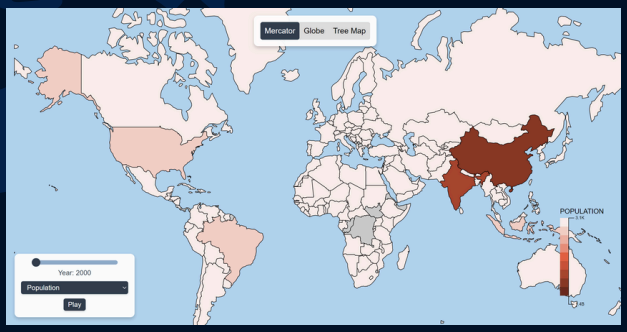


Finally, on the technical side, one of the struggles we faced was that we wanted to make the Mercator view and globe view use the same underlying SVG for performance and conciseness: we just wanted to change the projection. However, as both views use different zoom and drag functions, aligning this was quite a struggle. If a user drags the Mercator map around, we still do not want the globe to be off-center. After many hours of debugging, we managed to come up with a solution that was very satisfactory to us. The maps get reset to their original perspective every time a user changes tabs.

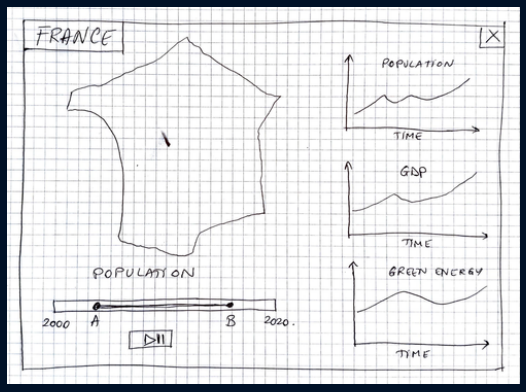
Sketches

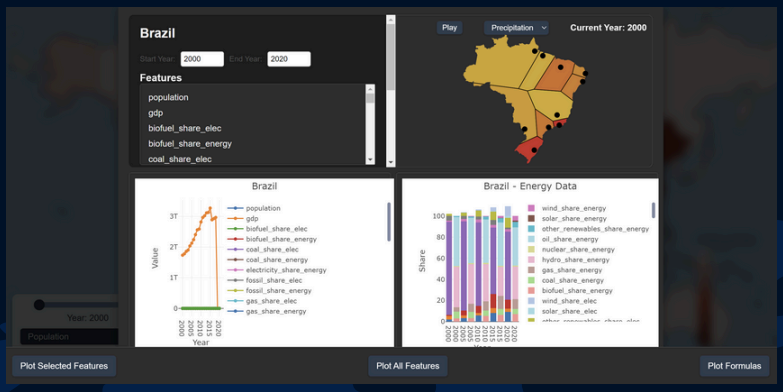
As previously mentioned, the evolution started from a Mercator map. The visitor of the website is thus able to see the global view initially. After the visitor gets a world view, they can switch to another view (globe or tree map) or plots (country window). We mostly followed our original sketches as produced for milestone 2 to design this page. We made some minor changes such as moving selectors around for a better user experience.



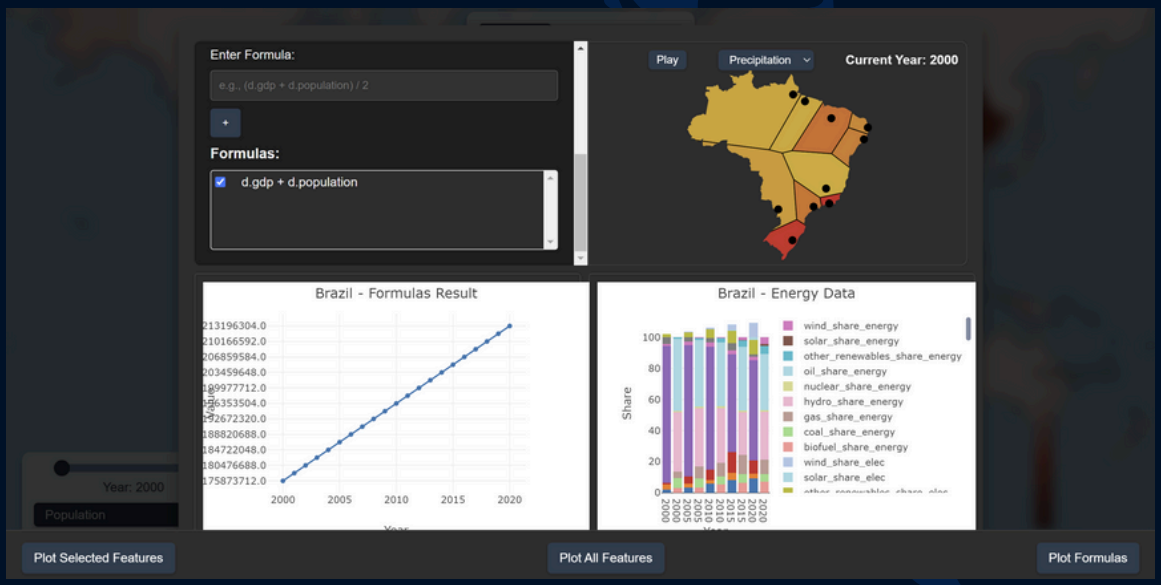


Regarding the country view, we tried multiple designs during the coding process. In the end, we have chosen to split the metrics into two plots, one with all the metrics we have for that specific country and one other plot with energy-related metrics, such as wind energy, solar energy, gas, etc.



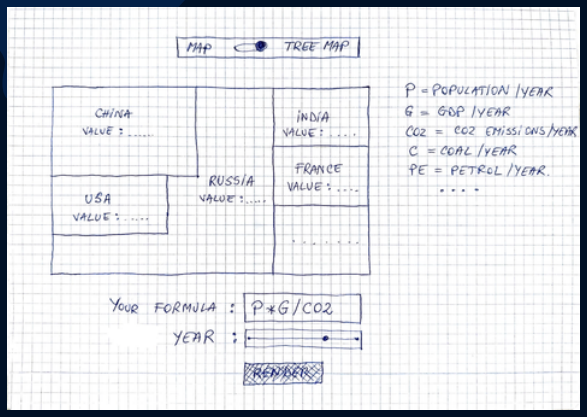


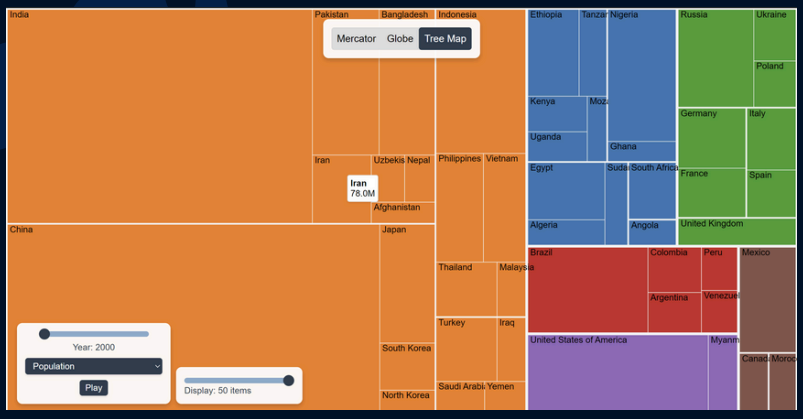
One of our extra ideas for this project was to add a formula box and in that way, the visitors to our website can see different metrics alone, but also manipulate the data themselves through formulas. For example, someone can plot GDP/Population or Wind Share of Electricity + Solar Share of Electricity. In that way, we empower users to design their metric preference and let them see that in our country-level view.



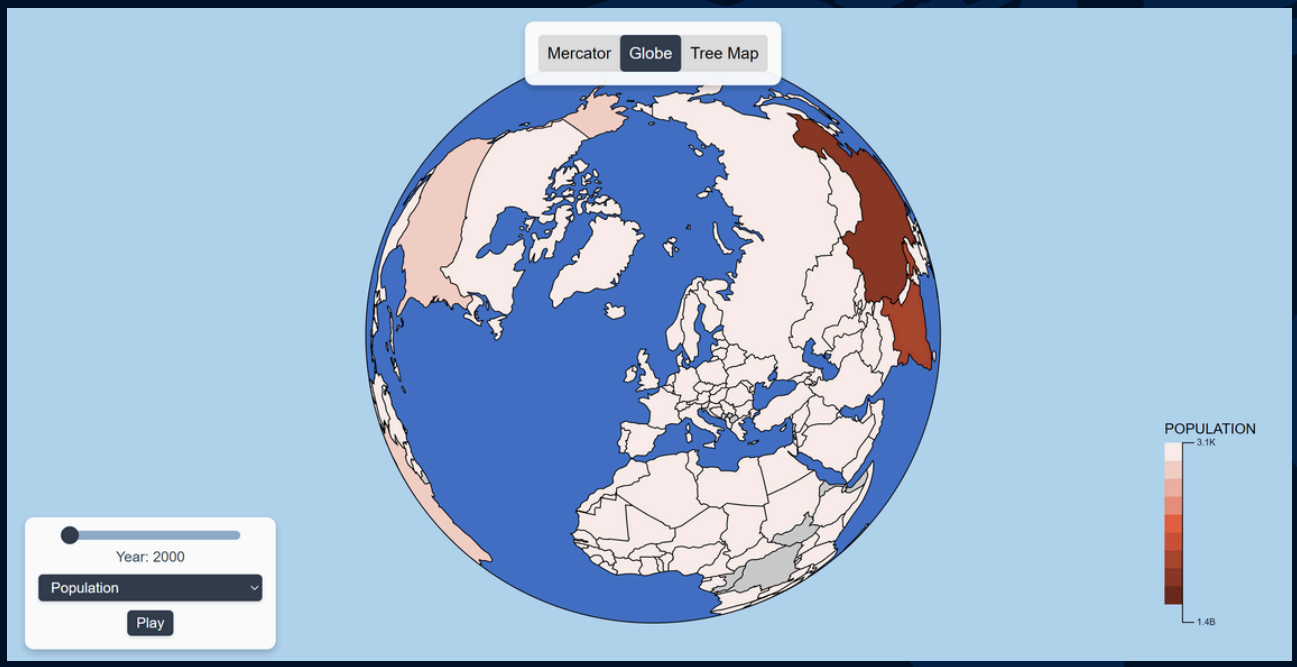
Sketches

Adding another world visualization was something we explored at the beginning, when designing the sketches. We were mostly interested in adding a Tree Map, which is a big rectangle and the top countries on a specific feature have a rectangle sized relative to the value of the metric that the user selects. For visibility reasons, we limited the user to adding up to 50 countries in the view.





As mentioned, the decision to add a globe view came after the lecture on maps. The globe view has the same features for the metric selector and year selector as the main map and you can drag and rotate the sphere however you want. This view allows users to visualize the globe as it is, rotate it, zoom in and out, and see the changes in metrics over the years. This view makes it a lot easier to compare countries that are close on the globe but far away on the Mercator map, such as Canada and Russia. Of course, it also shows the size of countries a lot more accurately than the Mercator map.



Peer Assesment

Work was divided evenly and a similar workload was shared by all team members. However, we often times also helped each other with tasks when someone was struggling. In the end, each team member played a crucial role in developing this tool. Below is a detailed breakdown of our tasks and contributions:

1. Daniel Mihai Baciu:
    a. Managed overall project workflow and coordination
    b. Contributed to frontend development
    c. Worked on project documentation, ensuring clarity and completeness
    d. Contributed to the D3.js country view visualization
2. Mohamed Amine Ben Ahmed:
    a. Led data preprocessing and integration efforts
    b. Integrated various data sources to create a cohesive and comprehensive dataset
    c. Contributed to the D3.js Mercator and country visualizations
3. Frederik Gerard De Vries:
    a. Worked on the globe projection and treemap visualization
    b. Focused on detailed mappings of individual countries
    c. Aligned different spatial datasets
    d. Ensured general accuracy and usability of the visualizations

Conclusion

We, the DataDrift Dream Team, have developed an interactive data visualization tool that illustrates the dynamics of climate change, energy consumption, and population trends. Our project enables a deeper understanding of the interconnected challenges facing our world today. Besides showing the issues we are facing nowadays, it also highlights the efforts being made to overcome the issues.

By leveraging modern data analytics and visualization techniques, our tool offers a comprehensive and engaging way to explore the relationships between these critical factors. Users can interact with the data, uncovering patterns and insights that might otherwise be a lot more difficult to comprehend.

We believe that our tool is able to empower scientists and the general public alike to make more well-informed decisions and get a more clear view of our efforts to combat this global problem.

Besides the website being able to be downloaded and viewed as described in the GitHub README file, it is also hosted on GitHub pages. It can be found on the following URL: https://com-480-data-visualization.github.io/DataDrift-Dream-Team/

Enjoy the website!