VIS-Assignment 5

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Motivation:

The overall problem is to help service providers for greenhouse emission compensation identify and offer effective mitigation projects to individuals and companies seeking to decrease their carbon footprint and implement disaster relief projects. The first tasks include investigating possibilities for climate change mitigation, identifying areas for land cover changes, assessing carbon sequestration potential in forests, understanding the frequency of climate-related disasters. The second task is to identify countries suitable for hosting renewable energy projects. In this design, a ChoroplethMap, Scatterplot, and a Barchart was used for the mitigation project. And also, a Scatterplot was chosen for the Energy Transition project.

User and Tasks:

Service Providers for Greenhouse Emission Compensation

- **User Profile:**
  These service providers offer solutions to individuals and companies aiming to mitigate their environmental impact. They specialize in developing and managing portfolios of carbon offset projects, which can include reforestation and renewable energy. Their clients are typically environmentally conscious entities that seek to invest in projects that compensate for their carbon footprint.

- **Tasks:**
  1. **Mitigation Project Identification:** Investigate possibilities to mitigate climate change effects which can be offered to frequent flyers who want to decrease their carbon footprint, e.g., planting trees, direct air capture, disaster relief, by analyzing the dataset for regions where such projects could have the greatest impact on carbon sequestration.
     - (Land Cover Accounts): The dataset contains valuable information on climate-altering land cover indices across various years, offering insights into evolving patterns. The Climate Altering Land Cover Index serves as an indicator, benchmarked against the base index of 100 in the year 2015. Some missing values for certain countries and years should be excluded from visualization.
     - (Forest and Carbon): We use data about carbon in forests to find the best places for environmental projects. The Index of Carbon Stocks in Forests, referenced against the base index of 100 in 1992, provides valuable insights. Notably, there are no missing values in this dataset.
     - (Climate-related Disasters Frequency): The dataset's information on the frequency of climate-related disasters was used to inform disaster relief projects. Focus on the

total frequency for this task, recognising that null values signify countries without incidents, allowing for their replacement with zeroes.

2. **Energy transition Project Identification:** Information on electricity generation and installed capacity, classified by energy type, can help service providers align their compensation offerings with renewable energy projects, thereby contributing to the energy transition.
    - (Energy Transition): The dataset provides information for identifying countries ready for energy transition projects. Key features, such as indicators (Energy Capacity and Generation), energy types (Renewable and Non-Renewable), units (Megawatt for Capacity and Gigawatt for Generation), and data spanning different years, are crucial for this task. Specifically, the Electricity Installed Capacity indicator proves instrumental in this context. There are some missing values in this dataset which lower the information gained for some countries, however, they can be excluded since they are mostly related to old time frames.

Prototype and Design process:

Discoveries and Visualizations:

- The **ChoroplethMap** initially intended to show Disaster Frequency has been repurposed to display the Carbon Stocks index over the Land Cover index. This dual metric overlay can highlight regions where land cover changes can have a significant impact on carbon sequestration.
- The **Scatterplot** reveals relationships between the Land Cover Index and the Carbon Stocks index, potentially identifying optimal areas for mitigation projects.
- The **Barchart** for Disaster Frequency illustrates the distribution of climate-related disasters, which can pinpoint regions needing urgent mitigation efforts.
- The **Renewable Energy Transition Project Identification** scatterplot demonstrates the potential for renewable energy projects by displaying non-renewable and renewable energy capacity. This can help in targeting investments towards countries with higher renewable energy potential.

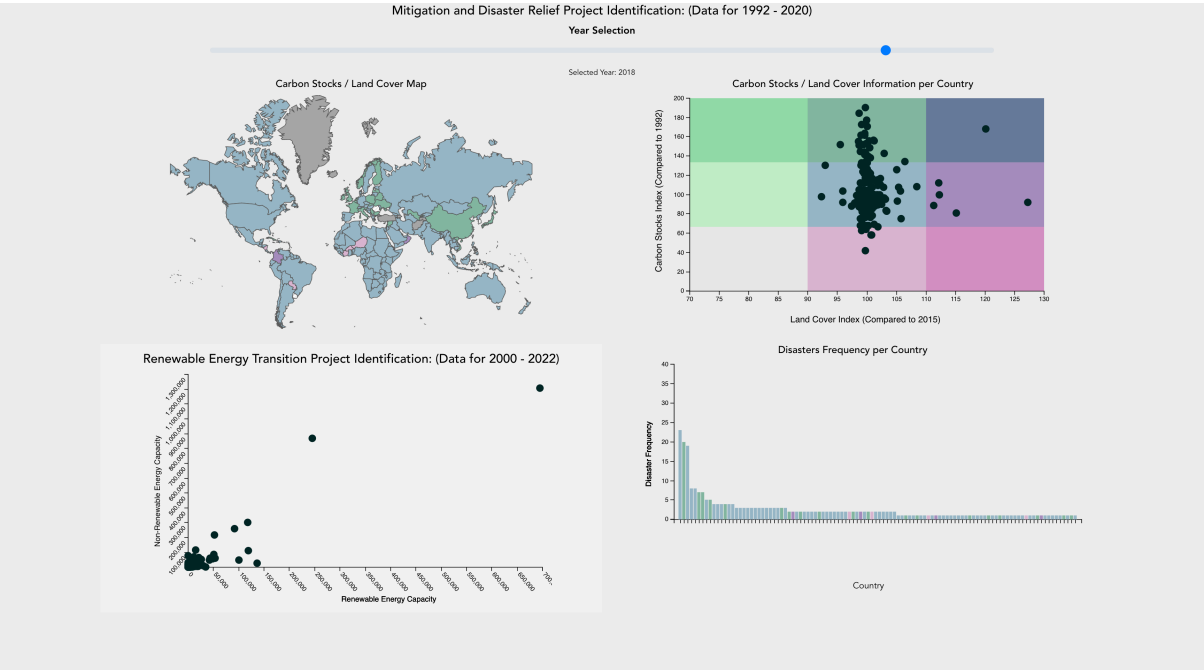
Visualization Ideas That Didn’t Work:

- Having a juxtaposed barchart for energy transition which did not show the necessary information in an accepted timeframe. Also, it was too cluttered and removing it added to the simplification of the dashboard.

Usage:

- Task-01: Using this visualization system will help users find information on Carbon Stocks and Land Cover for different countries which leads to mitigation projects. Also, using the Disasters Frequency, they can find countries in dire need of Disaster Relief projects.
- Task-02: Energy Transition Scatterplot will aid users to understand which countries have low renewable energy capacity. It is possible to compare renewable and non-renewable energy capacity of each country.

Implementation:



The final implementation is a dashboard consisting of four different views. Three views are dedicated to the first task (Mitigation Project Identification) which provide information over Land Cover data, Carbon Stocks data, and Disasters Frequency data, all three views are interactively connected (through brushing and selection). Users can go through these visualization and find out which countries are suited for a project on decreasing their carbon footprint and disaster relief. The final view is dedicated to the second task (Energy Transition Projects). Users can find out information about Renewable and non-Renewable Energy Capacities of each country.

Details: (Demo Available - Best with Chrome)

- A year slider was implemented to allow users browse through available data for each year and see the changes happening to each country during provided timeframe. The data available for Mitigation project is from 1992 to 2020 and for the Energy Transition project from 2000 to 2022. (going out of the timeframe for each task does not effect the view since it will only shows the available data).
- Choropleth Map for Carbon Stocks and Land Cover Indexes: Users can visually see a map colored based on Carbon Stocks index and Land Cover index (corresponding color on scatterplot).
    - Users may find more information with hovering the mouse over each country. The country will highlight on hover and a tooltip with numeric information on Carbon Stocks index, Land Cover index, and Disasters Frequency on the corresponding country will pop up.
    - Users may select multiple countries by clicking on each country.
    - Users may deselect with simply double clicking on the empty area on the map.
    - Countries with no data on Land Cover or Carbon Stocks are colored Gray.
    - Outliers are applied with a stripped pattern (not really outliers in this case, countries with bigger indexes were used to implement the idea - Note: maybe I shouldn't have left this in the final design, however, I wanted to get some feedback on the idea).

- Scatterplot for Carbon Stocks and Land Cover Indexes: Users can compare countries based on Stocks and Land Cover indexes. The scatterplot is divided into 9 color categories to be shown on the Choropleth Map.
    - Users may find more information with hovering the mouse over each country. The country will highlight on hover and a tooltip with numeric information on Carbon Stocks index, Land Cover index, and Disasters Frequency on the corresponding country will pop up.
    - Users may select multiple countries by clicking on each country.
    - Users may zoom in using the Brush tool. Only the brushed countries will be shown on connected plots.
    - Users may zoom out by simply double clicking on the scatterplot.
    - Zooming in has a transition to help users not lose focus (also, when selecting on the barchart, countries get removed with a transition to help users notice the deletion).
- Disasters Frequency Barchart: Users can compare countries based on Disasters Frequency.
    - Users may find more information with hovering the mouse over each country. The country will highlight on hover and a tooltip with numeric information on Carbon Stocks index, Land Cover index, and Disasters Frequency on the corresponding country will pop up.
    - Users may select multiple countries by clicking on each country.
    - Users may zoom in using the Brush tool. Only the brushed countries will be shown on connected plots.
    - Users may zoom out by simply double clicking on the scatterplot
    - To avoid visual cluttering, country names will not show on the X axis unless the user select countries or less countries are available to show (so it can clearly fit on the screen and stay readable)
    - Countries with no data or zero frequency are removed from the barchart.
    - Countries are color coded with the same categorization used in Choropleth Map and Scatterplot.
    - Brushing has a transition to help users not lose focus (also, when zooming on the scatterplot, countries get removed with a transition on the barchart to help users notice the deletion).
- Scatterplot for Energy Transition:
    - Users may find more information with hovering the mouse over each country. The country will highlight on hover and a tooltip with numeric information on Renewable and Non-Renewable Energy Capacity on the corresponding country will pop up.
    - Users may zoom in using the Brush tool.
    - Users may zoom out by simply double clicking on the scatterplot.
    - Zooming in has a transition to help users not lose focus.

Note: If users change the year while zoomed on a particular portion of a view, the zoom will not get removed so they see the changes over that area in more detail.

Deployed Dashboard -> https://wwwlab.cs.univie.ac.at/~jabbarir79/VIS23W/A5/

Demo -> https://wwwlab.cs.univie.ac.at/~jabbarir79/VIS23W/A5-pre/

Footprint Scatterplot -> https://wwwlab.cs.univie.ac.at/~jabbarir79/VIS23W/A5-pre/sct_fp.png
Footprint Choropleth Map -> https://wwwlab.cs.univie.ac.at/~jabbarir79/VIS23W/A5-pre/choro.png
Disaster Relief Barchart -> https://wwwlab.cs.univie.ac.at/~jabbarir79/VIS23W/A5-pre/histo.png
Energy Transition Scatterplot -> https://wwwlab.cs.univie.ac.at/~jabbarir79/VIS23W/A5-pre/sct_energy.png

Discussion

What I learned:

- **Education on the subject:** It is important to have enough knowledge before starting a visualization project. I found it quite challenging to understand datasets and make sense of some data features.
- **Overview / Detail views for Energy transition:** It would be better to have another view connected to Energy Transition Scatterplot to show more information on Energy Capacity, Energy Generation, and different types of Renewable Energy (Capacity / Generation). This way, users would understand why a country has low renewable energy and what would be the best option.
- **Disaster Relief Task:** In this project, Carbon Footprint mitigation and Disaster Relief were treated as one task. Although, it would make more sense to tread disaster relief as a separated task and study it more.
- **Transition and Selection:** Going back, I would spend more time on designing transitions and selections. For example, removing data points from scatterplot on selection causes some distraction.

What I would Improve:

- **Adding Real-time data stream:** This would allow the dashboard to provide the most current insights, making it an even more valuable tool for decision-making.
- **Advanced Filtering:** Allowing users to filter views to the smallest detail will allow them to capture the most unique information hidden from the eyes. Also, data on world-wide countries has proven to be big for normal visualization, it would add more to user's understanding to be able to lower the visual clutter in a sensible way.

Users:

As it was explained before in Prototype: Usage section, users can solve the tasks with using this dashboard.

- Using the carbon footprint scatterplot, users can learn about Carbon stocks and Land Cover present in each country.
- Using the map, users can locate interesting countries and compare to each other using the color code and location.
- Using the barchart, users can find information related to Disaster Relief project.
- Using the energy transition scatterplot, users can compare renewable/non-renewable energy capacities of countries.

Users Issues:

- Users don't have more detail on Renewable/Non-Renewable Energy Capacity/Generation and different types of energy.
- Some countries have missing data on Carbon Stocks, Land Cover, and Disasters Frequency, which makes it impossible to provide visual data and show trends for those specific countries.

Conclusion:

This project shows that data visualization is a really useful tool for tackling environmental issues. The dashboard we created helps companies find the best places for projects that help the environment, like planting trees or setting up renewable energy sources. It uses a lot of different data, like how land is used, how much carbon is stored in forests, how often natural disasters happen, and how much renewable energy is available in different countries.

The cool thing about this dashboard is that it makes complicated data easy to understand. Users can quickly see where the biggest environmental needs are and make smart decisions about where to work. The dashboard is interactive, so users can zoom in on data, use filters, and get more details, which makes it more engaging.

In the future, there are lots of ways to make this dashboard even better. Adding up-to-date data, more types of charts and graphs, and changing it based on what users say they need could make it a really powerful tool for fighting climate change. This project is a great start and shows how important and helpful data visualization can be for environmental planning and action.