INFOSCI301 | Prof. Luyao Zhang | Yiqing Wang

Visualization Redesign Project

Academic Report

1. Theory-Based Critique

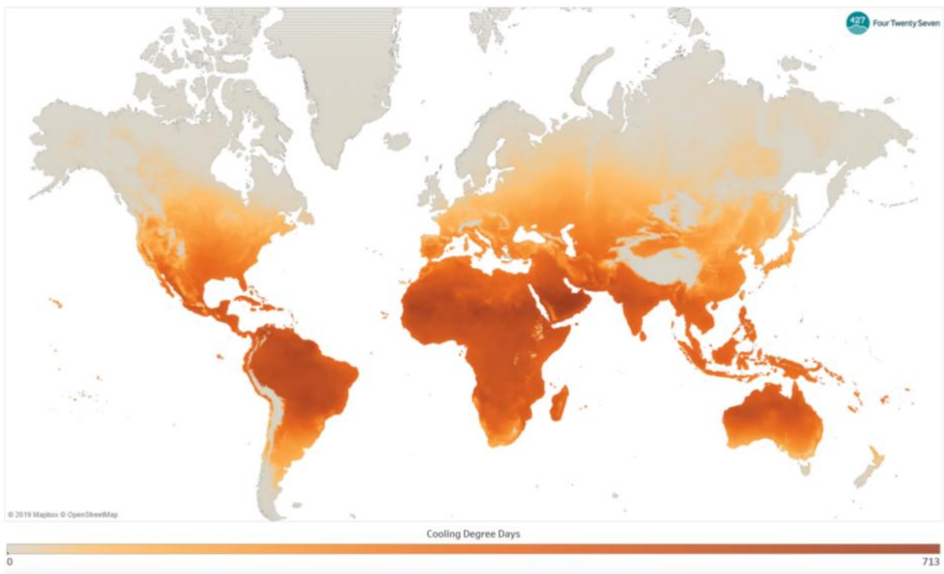


Figure1: Static choropleth map visualizing the projected increase in Cooling Degree Days (CDD) across the globe. Gained from: https://aws.amazon.com/cn/blogs/publicsector/leveraging-the-cloud-for-rapid-climate-risk-assessments/

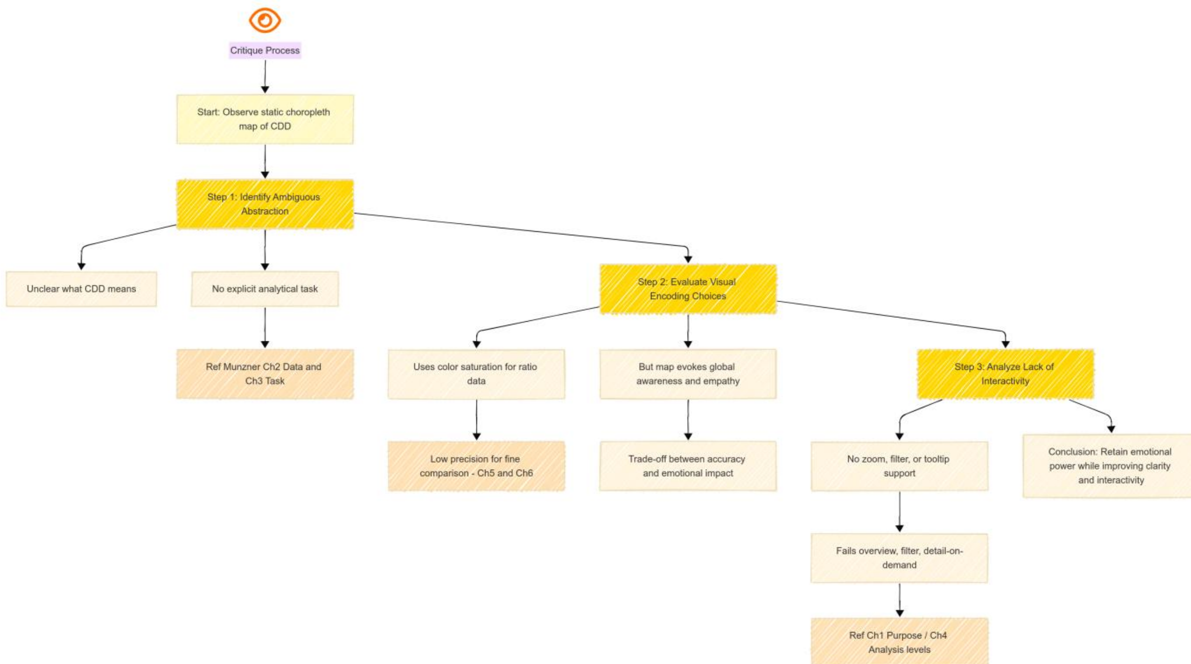


Figure2. Flowchart of Critique Process (Created by Mermaid Live Editor)

The map lacks contextual framing of what Cooling Degree Days (CDD) represent and fails to clarify its analytic goals. Without definitions or annotations, viewers cannot discern whether the map is designed for comparative analysis, identifying hotspots, or policy decision-making. This undermines the task abstraction layer, which according to Munzner (2014), is essential for aligning visual encoding with user intent (Ch. 3).

While the map uses continuous orange hues to convey quantitative differences, it relies heavily on color saturation—a low-precision visual channel for encoding ratio data (Munzner, Ch. 5). This makes it difficult to make fine-grained comparisons between regions. However, replacing it with bars or lines, though more precise, would sacrifice the geographic continuity and emotional resonance that maps inherently provide. Choropleth maps, while imperfect in precision, preserve a holistic worldview and invite empathy and global awareness—features essential to communicating climate data. Therefore, the current design is emotionally effective but analytically limited, revealing a trade-off between perceptual clarity and narrative cohesion.

As a static visualization, the map does not support interactive exploration, such as zooming into specific regions, filtering by time frames, or comparing CDD projections across socioeconomic indicators. According to Munzner's multi-level task framework (Ch. 4), such functions are vital to enabling overview, drill-down, and detail-on-demand. Without them, the map remains surface-level, limiting both its usability and analytical potential.

References

Munzner, T. (2014). Visualization analysis and design. CRC Press.

Knsv, & Mermaid Community. (2024). Mermaid Live Editor. https://mermaid.live/

2. Research Analysis: Affective Visualization Design

Paper's link: https://ieeexplore.ieee.org/abstract/document/10301796

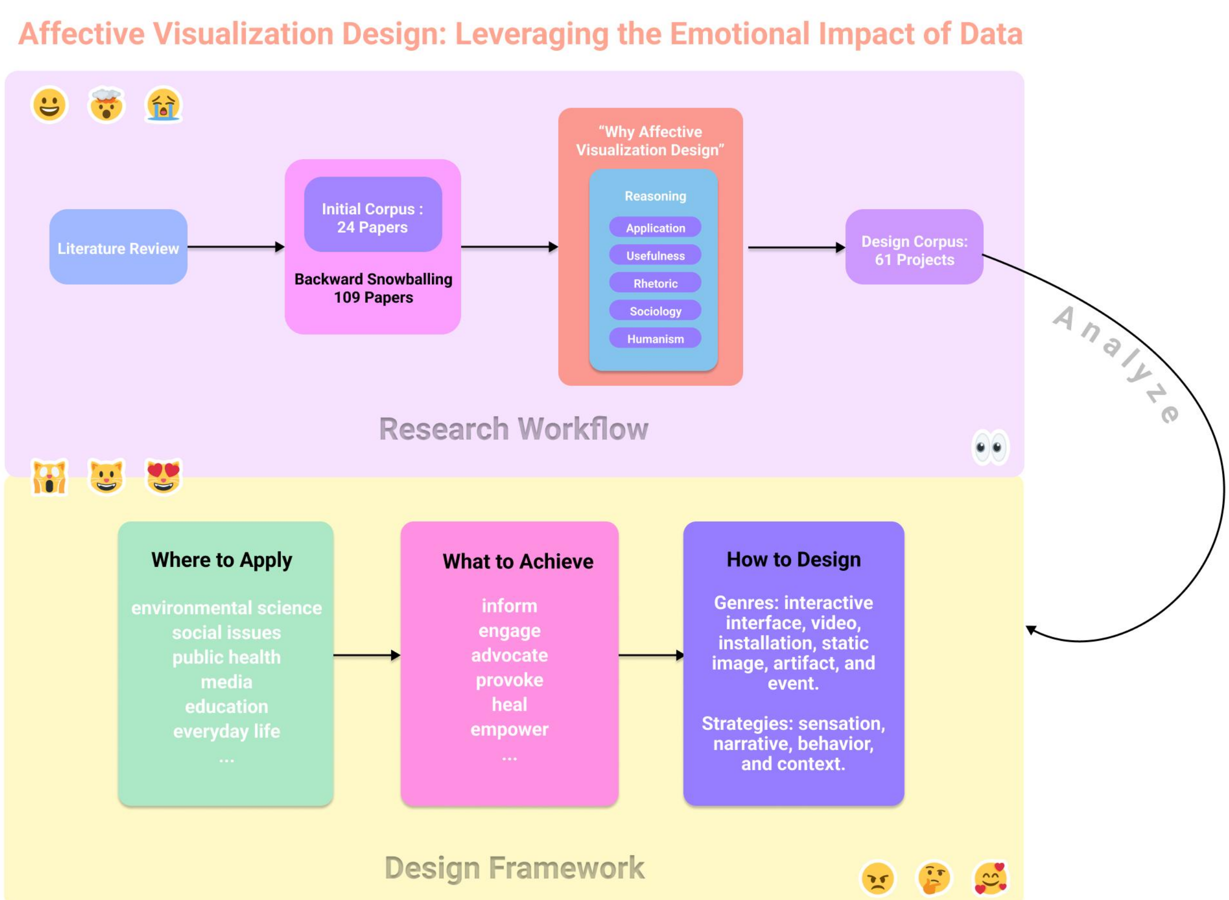


Figure3: Research pipeline of the paper (Created by figma)

1. Background

Traditional data visualization emphasizes clarity, accuracy, and neutrality, often avoiding emotional elements. Yet recent work has shown that tools like color, metaphor, and narrative can enhance emotional engagement. Despite rising interest, affective visualization still lacks a clear definition. Lan et al. (2023) respond by reviewing 109 studies and proposing a structured framework for designing emotionally resonant visualizations.

2. Motivation

Emotional design can improve how users connect with complex or urgent data. It helps attract attention, enhance memory, and support reflection or action. Critics worry it might undermine objectivity, but the authors argue that emotion, when used ethically, can humanize data and improve communication, especially in fields like climate change or social justice.

3. Research Question

The central question asks how affective visualization can be defined, justified, and applied as a valid method. This is supported by three sub-questions: why emotion matters, where and how it is used, and what framework can guide future design.

4. Application Scenarios

The authors introduce a three-part framework: “Where” affective visualization appears (e.g., environment, health, society); “What” it aims to do (engage, provoke, heal); and “How” it is implemented (e.g., sensory design, storytelling, contextualization). This model supports meaningful, ethical design decisions.

5. Methodology

A qualitative, corpus-based method was used. Starting from 24 papers, the authors expanded to 109 through snowball sampling. They conducted thematic analysis and coded 61 design projects based on where, what, and how affective elements were used. This ensured both breadth and depth in analysis.

6. Results

The study identifies five justifications for emotional design—practical relevance, cognitive support, rhetorical framing, cultural influence, and human-centered values—and maps a three-dimensional space showing domains, goals, and methods of affective visualization.

7. Intellectual Merit

The work defines affective visualization as a legitimate design strategy, distinct from visualizing emotional content. It bridges theory and practice, introducing a reusable framework that integrates ethics, communication, and user-centered design.

8. Practical Impacts

The findings offer useful guidance for journalism, advocacy, and UX design. Emotional visualizations can increase engagement, deepen understanding, and foster empathy, helping create more human-centered data tools.

Reflection and Relevance to Redesign

This paper informs my redesign of the CDD choropleth map by emphasizing how emotional engagement can complement analytical clarity. While original visualization relied solely on color saturation to convey data intensity, affective principles—like metaphor, contextual storytelling, or more nuanced interactivity—could help viewers better relate to climate trends.

Moreover, Mahyar (2024) emphasizes that climate visualizations should move beyond static formats to support interactivity, contextual relevance, and broader accessibility. Her framework highlights the importance of designing tools that empower users to explore and connect with data more personally. In redesigning my CDD map, I plan to incorporate interactive features such as a timeline slider to view changes over time and a comparison mode to contrast different regions. These exploratory interactions can help users better understand localized climate impacts and engage more deeply with the data. Drawing from color psychology research, I also applied a purple hue at the extreme end of the temperature scale, as purple can symbolize emotional intensity and signal exceptional or rare conditions in environmental contexts (Ackerman, 2022; Elliot & Maier, 2015).

References

Ackerman, E. (2022, November 10). Color psychology for kids: How color affects behavior and learning. The Spruce. https://www.thespruce.com/color-psychology-for-kids-2504750

Elliot, A. J., & Maier, M. A. (2015). Color psychology: Effects of perceiving color on psychological functioning in humans. Frontiers in Psychology, 6, 368. https://doi.org/10.3389/fpsyg.2015.00368

Lan, X., Wu, Y., & Cao, N. (2023). Affective visualization design: Leveraging the emotional impact of data. *IEEE Transactions on Visualization and Computer Graphics*, 29(1), 1–10. https://doi.org/10.1109/TVCG.2022.3209372

Mahyar, N. (2024). Harnessing visualization for climate action and sustainable future. *Proceedings of the IEEE VIS Conference*. https://doi.org/10.48550/arXiv.2410.17411

3. Practical Tool Insights

To prepare for my visualization redesign, I explored several tools to understand how platforms balance analytical clarity with emotional expression. In Exercise 2, I compared **Amazon QuickSight** and **Reality Composer**. While QuickSight excels at building interactive analytical dashboards, it lacks flexibility for affective design. In contrast, Reality Composer supports more immersive, emotionally resonant experiences through spatial layout and narrative interaction.

I also experimented with **Google Colab**, which provides fine-grained control over visual design using **Python libraries like Plotly**. Unlike GUI-based tools, Colab enables custom visualizations that combine statistical rigor with expressive storytelling. For example, I tested color gradients to evoke climate anxiety and added data annotations to reinforce narrative context.

Ultimately, I chose Google Colab for its versatility, reproducibility, and ability to support dynamic, emotionally engaging visualizations. It allowed me to build an interactive choropleth map that integrates affective color schemes and contextual cues to communicate both data trends and emotional urgency.

References

Amazon Web Services. (n.d.). Amazon QuickSight. Retrieved April 13, 2025, from https://quicksight.aws.amazon.com/

Google. (n.d.). Google Colaboratory. Retrieved April 13, 2025, from https://colab.research.google.com/

4. Redesign Summary & Implementation

1. Redesign Summary

Title: *Feeling the Heat: An Interactive Redesign of Global Climate Visualization*

Inspiration Sources

This redesign is informed by several key sources. Theoretically, Tamara Munzner's *Visualization Analysis and Design* (2014) provides foundational guidance on visual encoding channels, task abstraction, and multi-level validation. From the research side, Lan, Wu, and Cao's (2023) work on *Affective Visualization Design* inspired the use of emotionally resonant elements such as color gradients, narrative overlays, and empathetic framing. Mahyar's (2024) framework for climate communication emphasized interactivity, immersion, and contextual embedding to promote accessibility and user agency.

In addition, feedback from **Prof. Binbin Li (Environmental Science, DKU)** prompted the integration of localized climate narratives. She emphasized the importance of letting users reflect on personal spaces and timelines—highlighting that "sometimes what we need is not efficiency, but patience" when engaging with uncertain climate stories. This feedback directly shaped the inclusion of a city-specific temperature timeline to complement the global view.

Redesign Advancement

The original choropleth map critiqued in Exercise 3 visualized projected global heat intensity using static color saturation alone, but lacked contextual narrative, emotional framing, and interactive functionality. Moreover, the dataset it relied upon was not publicly available, limiting reproducibility and ethical transparency.

To address these issues, I redesigned the visualization using two open-access datasets:

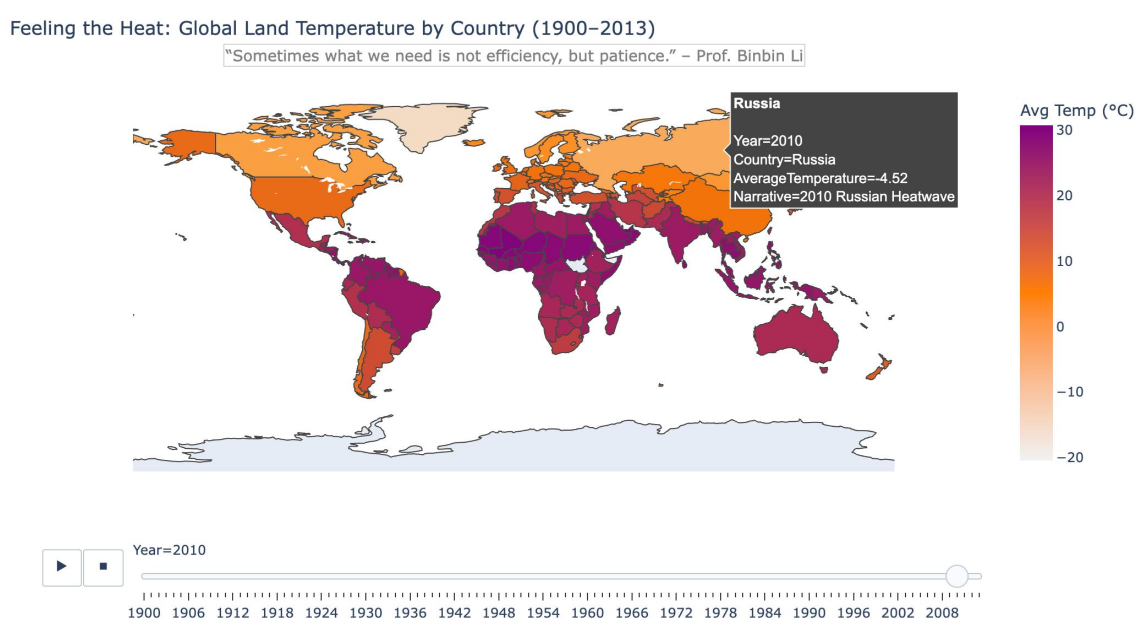
- **GlobalLandTemperaturesByCountry.csv** (Berkeley Earth via Kaggle), which provides monthly country-level average land temperatures from the 18th century onward.

- **NYC_Central_Park_weather_1869-2022.csv** (Dan Braswell via Kaggle), which offers daily historical temperature data for New York City, enabling a localized and personal storytelling extension.

The redesign improves upon the original in the following key ways:

1. **Affective color encoding**: A custom gradient (bone white → orange → flaming purple) was used to communicate the emotional urgency of global warming.
2. **Interactive choropleth map**: Built with Plotly, the global view allows users to explore country-level trends from 1900 to 2013.
3. **Animated timeline slider**: Enables temporal exploration with fine-grained control and visual continuity.
4. **Hover-based tooltips with narrative cues**: Users can access precise temperature values and contextual annotations (e.g., 2003 European heatwave).
5. **City-level time series extension**: An interactive temperature trendline for New York City (1869–2022) complements the global map and encourages personal reflection on climate change over time.
6. **Reflective annotation**: A design quote from Prof. Li is embedded in the visualization, reminding viewers to embrace uncertainty and patience rather than seeking immediate, categorical conclusions.

2. Implementation



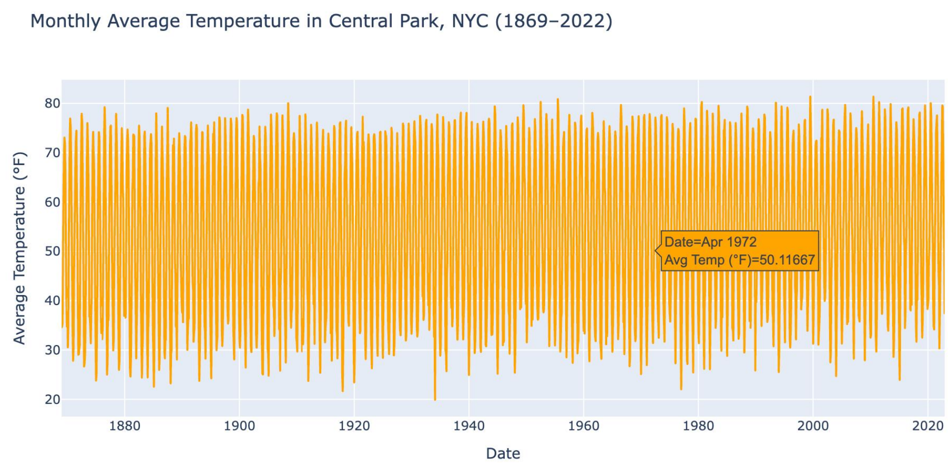


Figure4&5: Redesign Choropleth Map of Global Climate Visualization

The redesigned visualization was implemented in **Google Colab** using **Python**, primarily leveraging Plotly for interactive choropleth mapping and Pandas for data transformation. The dataset used, *GlobalLandTemperaturesByCountry.csv*, was sourced from Berkeley Earth via Kaggle. Though it does not provide direct measurements of Cooling Degree Days, it contains historical and geographic surface temperature data that allows for the visualization of long-term climate warming patterns.

3. Data & Code Availability Statement

All code and visualization outputs are available in the following GitHub repository:

- **GitHub Repository**: https://github.com/Yiqing-Wang-05/design_graph

Dataset Source

This project uses two open-access datasets to support both global and localized climate visualizations:

1. **GlobalLandTemperaturesByCountry.csv**

   Provided by the **Berkeley Earth** climate initiative and distributed via **Kaggle**, this dataset contains **monthly country-level average land temperatures** from the **18th century to 2013**. Although it does not directly measure Cooling Degree Days (CDD), it serves as a reliable proxy for exploring long-term global warming trends across regions.

The dataset is **peer-reviewed**, compiled in collaboration with the **Lawrence Berkeley National Laboratory (U.S. Department of Energy)**, and integrates over **1.6 billion records from 16 archives**—ensuring transparency, reproducibility, and scientific credibility.

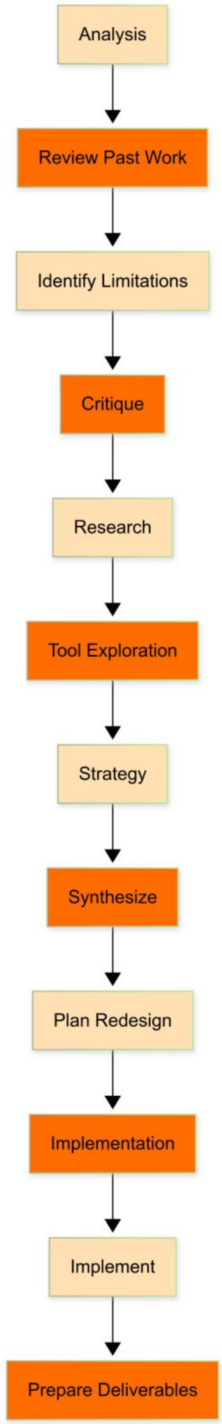
Kaggle dataset link:
https://www.kaggle.com/datasets/berkeleyearth/climate-change-earth-surface-temperature-data

2. **NYC_Central_Park_weather_1869-2022.csv**

   Sourced from **Kaggle**, this dataset records **daily weather observations in Central Park, New York City**, including high and low temperatures, from **1869 to 2022**. It was used to create a city-level temperature timeline as an extension of the global map, supporting user empathy and personal reflection.

   This design choice was inspired by feedback from **Prof. Binbin Li**, who emphasized the importance of grounding climate data in local experiences to foster patience and emotional engagement.

Kaggle dataset link:
https://www.kaggle.com/datasets/danbraswell/new-york-city-weather-18692022



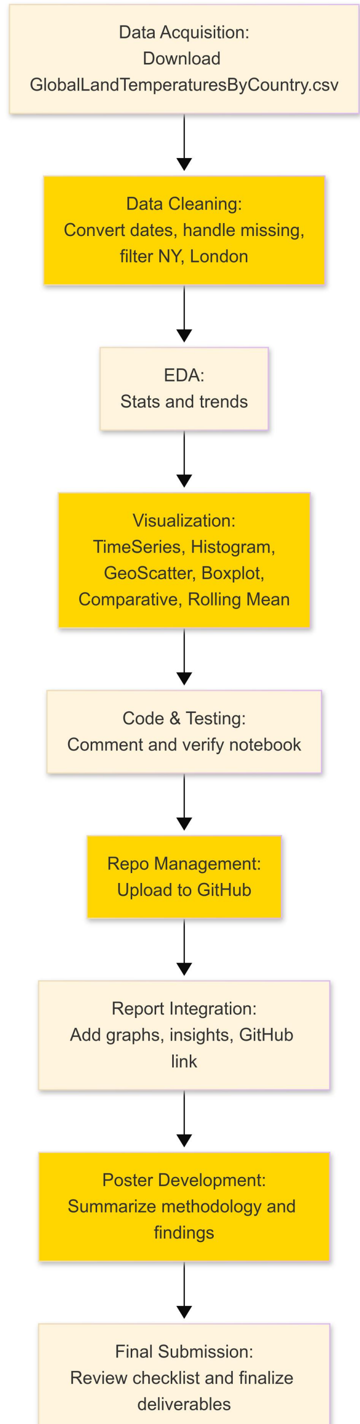


Figure6(left). The overall redesign workflow (Created by Mermaid Live Editor)

Figure7(right).The final project implementation process (Created by Mermaid Live Editor)

Contribution to Sustainable Development Goals (SDGs):

The project aligns with the following Sustainable Development Goals (SDGs):

- **Goal 13: Climate Action**

  By visualizing long-term global and localized temperature trends through emotionally engaging and interactive designs, this project raises awareness about climate change and promotes urgent action toward environmental sustainability.

- **Goal 4: Quality Education**

  Through enhancing the emotional accessibility and user engagement of complex climate data, the project supports education initiatives aimed at fostering a deeper public understanding of global environmental issues.

- **Goal 11: Sustainable Cities and Communities**

  By integrating localized data narratives, such as the New York City temperature timeline, this project encourages reflection on how climate change impacts local communities, thereby promoting awareness and action toward more resilient and sustainable urban development.

Figure8-10. Logos for SDG 13 (“Climate Action”), SDG 4 (“Quality Education”), and SDG 11 (“Sustainable Cities and Communities”), retrieved from https://sdgs.un.org/goals/goal13

Future Research Direction on Digital Humanities

During our visit to the *Mystery of Life Museum* in Zhouzhuang, I was struck by an exhibit where two plastinated human specimens—one muscular, one skeletal—were shown holding hands in a joyful posture (see Figure 11). As the guide explained, this gesture was deliberately arranged to soften the viewer's fear of death and anatomy, replacing dread with curiosity and even warmth.

This curatorial choice reminded me that **designers are not just data visualizers—they are emotional communicators**. In climate visualization, it is easy to fall into the trap of evoking fear: images of rising seas, burning forests, or red-saturated heat maps often aim to shock viewers into action. But research in behavioral science suggests that **hope and positivity often inspire more sustainable engagement than fear**. Fear might prompt short-term reactions, but it can also lead to avoidance, anxiety, or denial. Lasting change, however, stems from people being moved by *what is possible*, not just what is threatening.

Inspired by this, my future work in climate data visualization will explore how to **frame environmental urgency through confidence, health, and collective resilience**. Instead of portraying users as passive victims of climate change, I aim to design tools that encourage reflection, agency, and participation—grounded in human values and everyday lived experiences.

Figure 11. Two plastinated human specimens displayed in a joyful posture at the Mystery of Life Museum, Zhouzhuang. Image captured by the author during the DKU field trip on April 25, 2025.

GitHub Repository Link

- **GitHub Repository**: https://github.com/Yiqing-Wang-05/design_graph

Acknowledgments

Thanks to Prof. Zhang for instructional support, and to all peers whose feedback helped shape this project. And also thanks guest speakers David Schaaf and Dongping Liu for their inspiring insights on immersive education and real-world visualization applications. And special thanks to Prof. Binbin Li (Environmental Science, DKU) for her insights on the emotional power of local context and the importance of patience and open-ended reflection in climate communication.

References

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