Visualizing CO_2 and Air Quality Data and using Color Scales for Effective Communication

Background

Data visualization transforms complex datasets into comprehensible formats, supporting fields such as environmental sciences in interpreting data trends and disparities. For climate data, such as CO_2 emissions and air quality metrics (e.g., $PM_{2.5}$, PM_{10}, NOx), visualization helps communicate vital insights to the public and policymakers. Comparative visualizations highlight regional differences, while color scale choices impact users' perceptions, particularly when conveying critical indicators like CO_2 and temperature. This thesis will investigate the effectiveness of visualizations and color schemes in enhancing public understanding of climate data, with the goal of developing best practices in climate data visualization.

Problem Specification

Effectively communicating climate data poses challenges due to its complexity and scale, especially in representing differences across regions or time. Comparative visualizations may provide a way to convey variations in CO_2 and other air quality metrics across locations; however, it remains unclear how effective these approaches are for users attempting to interpret this information accurately. Additionally, the impact of different color scales on viewers' comprehension and perception of climate risks are particularly of interest for both climate data and air quality data. This thesis will explore these visualization challenges to inform design strategies that improve clarity and accessibility of critical climate data.

Suggested Method

The study will begin with a literature review on visualization methods, including comparative and color scale visualization techniques for environmental data. For visualization, various datasets can be used as mentioned further below. The data collected from different datasets may need to be preprocessed to enable consistent cross-regional comparisons. Visualizations are to be created to explore regional data comparisons and color scale variations. A user study shall evaluate comprehension, accuracy, and subjective responses, examining participants' ability to interpret and assess the visualizations. The

findings will guide recommendations for effective design strategies that optimize public understanding of climate data through comparative layouts and color choices.

Datasets

Data for this project can be gathered from the following sources:

- OpenAQ air quality database [Link],
- World Health Organization air quality database [Link], and
- Emissions Database for Global Atmispheric Research (EDGAR) [Link].
- There is also a possibility of using data collected by a company in Sweden for this project.

Relevant Articles

[1] Luo, X., Jiang, R., Yang, B., Qin, H., & Hu, H. (2024). Air quality visualization analysis based on multivariate time series data feature extraction. Journal of Visualization, 1-18.

[2] Liu, D., Cheng, K., Huang, K., Ding, H., Xu, T., Chen, Z., & Sun, Y. (2022). Visualization and analysis of air pollution and human health based on cluster analysis: a bibliometric review from 2001 to 2021. International Journal of Environmental Research and Public Health, 19(19), 12723.

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[4] Dasgupta, A., Poco, J., Rogowitz, B., Han, K., Bertini, E., & Silva, C. T. (2018). The effect of color scales on climate scientists' objective and subjective performance in spatial data analysis tasks. *IEEE transactions on visualization and computer graphics*, *26*(3), 1577-1591.

[5] Reda, K., & Szafir, D. A. (2020). Rainbows revisited: Modeling effective colormap design for graphical inference. *IEEE transactions on visualization and computer graphics*, *27*(2), 1032-1042.

[6] Ahmad, J., Huynh, E., & Chevalier, F. (2021, October). When red means good, bad, or Canada: exploring people's reasoning for choosing color palettes. In *2021 IEEE Visualization Conference (VIS)* (pp. 56-60). IEEE.

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[8] Horálek, J., Schreiberová, M., Schneider, P., Kurfürst, P., Schovánková, J., & Ďoubalová, J. (2018). European air quality maps for 2017: PM10, PM2. 5, Ozone, NO2 and NOx spatial estimates and their uncertainties. *ETC/ACM Tech. Pap*, *2017*, 110. [Link]

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