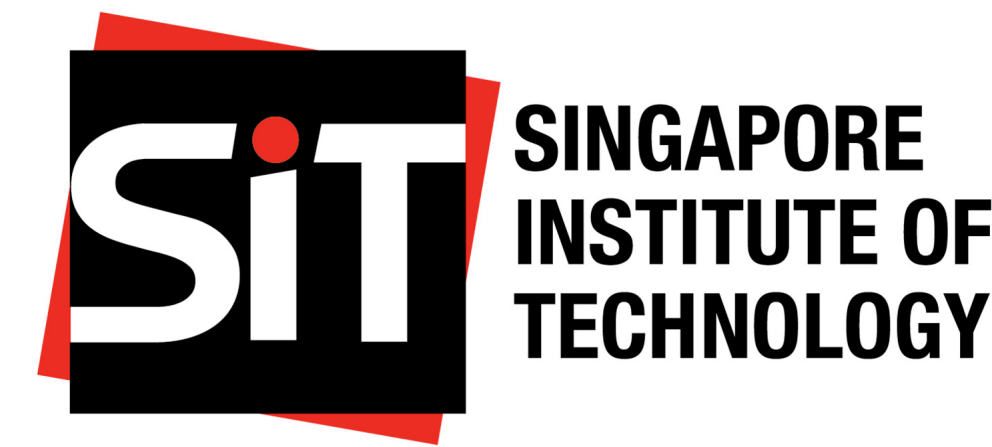# Visualizing Weather Extremes in Singapore 2023

Team Violetred   (Ang Guo Zheng Frederick, Abdul Halim Bin Abdul Rahim, Mirza Anaqi Bin Muhammad Haizan, Mark Peng Jung Zen, Fong Kah Kian, Amanda Chan Hui En)
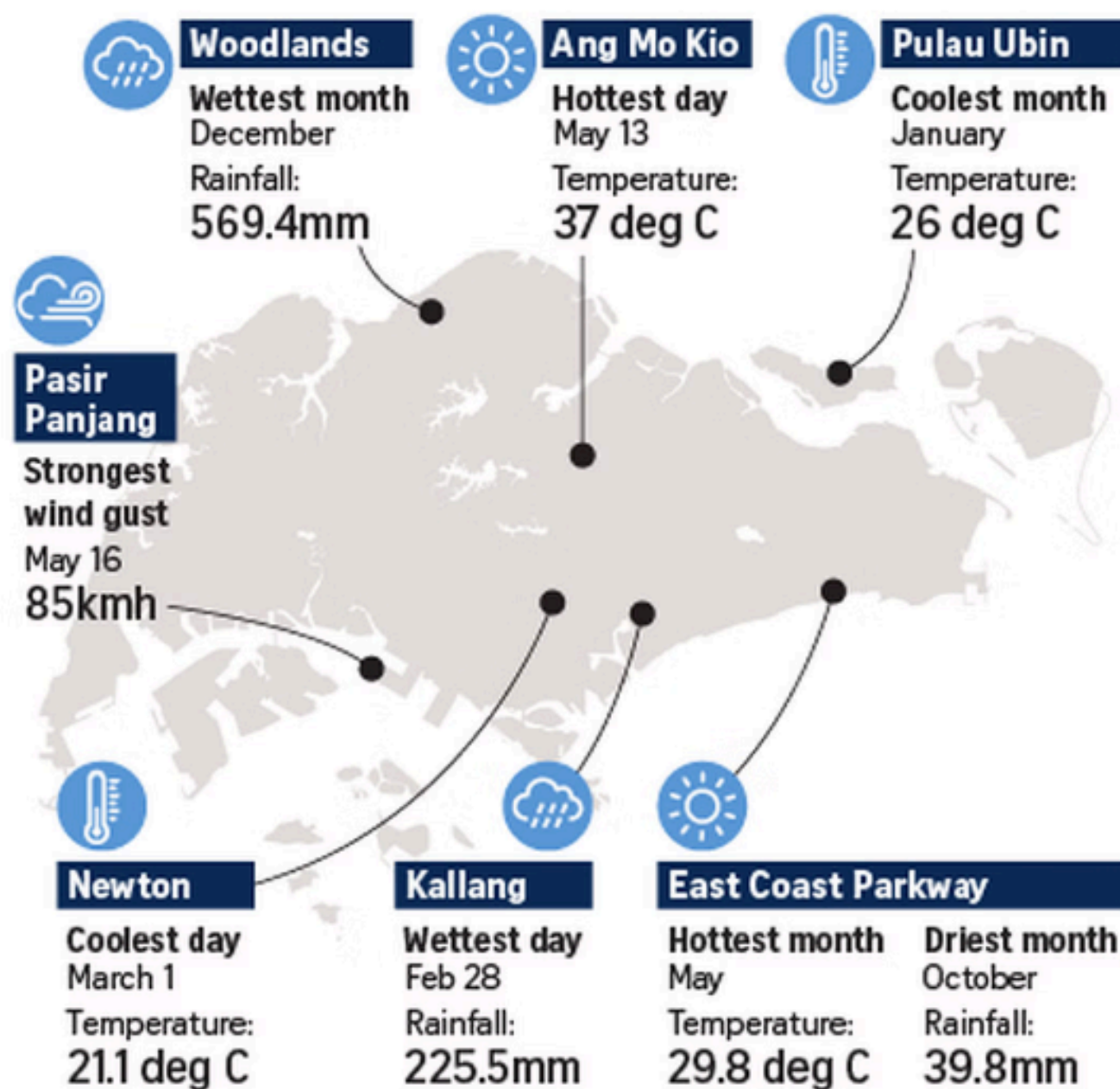
SiT SINGAPORE INSTITUTE OF TECHNOLOGY

Introduction

In 2024, Singapore is expected to experience even warmer weather than in 2023, which was the fourth warmest year on record for the country. The forecasted heat is due to the lingering effects of the El Niño climate phenomenon that impacted Singapore in the second half of 2023. Additionally, the positive Indian Ocean Dipole (IOD) conditions contributed to the elevated temperatures. Singapore's location between the Pacific and Indian oceans makes it more susceptible to climatic changes in both regions[1].

Making use of Singapore's weather data from 2023, the effects are illustrated with an annotated map where it showcases the map of Singapore pointing to areas which experience the different kinds of "Weather Extremes"(Figure 1). The map includes arrows that point to regions stating the significant weather condition, such as "Coolest Day" or the "Driest Month", the date it occurred and its respective statistical value.

Previous Visualization

Figure 1: Weather Extremes in 2023, published by the The Straits Time.

Strengths

- Provides an easy-to-understand overview of the extreme weather conditions faced in Singapore in 2023.
- Uses arrows with clear and concise labels to highlight significant weather conditions and their respective statistical values (Figure 2). Communicates the spatial distribution of weather extremes across different regions of Singapore.

[1]<Han, G. Y. (2024, March 25). S'pore may be hotter in 2024 than 2023 due to lingering effects of El Nino: MSS report. Retrieved from The Straits Times: https://www.straitstimes.com/singapore/environment/s-pore-may-be-hotter-in-2024-than-2023-due-to-lingering-effects-of-el-nino-mss-report?close=true>

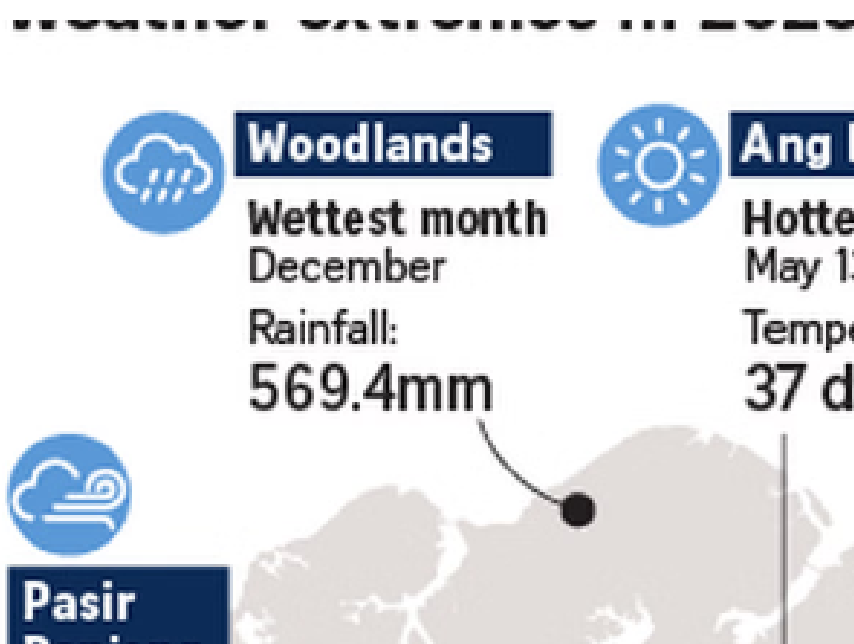- Uses different icons to improve readability and quick identification of each weather extreme.

Figure 2: Zoomed-in screenshot of the weather condition label.

Suggested Improvements

1. **Color Coding:** To improve clarity, we can color code or improve upon the current icons to better describe the individual weather details and to show which data points hit the extremes in terms of Singapore weather conditions. We should use a distinct color range for different weather events that is color-blind friendly (eg. such as blue/red, blue/orange, blue/brown for the range of coldest/wettest to hottest/driest). This will make it easier to differentiate between types of data at a glance.
2. **Legend:** To prevent confusion and improve efficiency in reading the visual, we can include a legend explaining what the color range and icons represent.
3. **Layered Related Data:** We can layer data related to weather conditions such as water bodies on how it will affect rainfall, population density relating to relative temperature of region, etc.
4. **Annotations:** We could also have the option of briefly annotating notable records or events (eg. "hottest day in the past decade") to highlight significant points of interest.

Implementation

Data

- The Meteorological Service Singapore (data.gov.sg) provide detailed weather statistics and real-time weather readings across Singapore, which can be scraped and used in our visualization[2].
- Kaggle provides us with the Singapore City Geo-Coordinates to be used as the base of our choropleth map visualization[3].
- From SingStat.gov.sg we retrieved the population density of Singapore Residents by Planning Area statistics to be layered on top of the visualization[4].
- From Data.gov.sg, we extracted the water bodies in Singapore to be layered on top of the visualization as well[5].

Software

We used the Quarto publication framework and the R programming language, along with the following third-party packages:

- *readxl* for data import
- *tidyverse* for data transformation, including *ggplot2* for visualization based on the grammar of graphics
- *ggrepel* for labeling data points in plots

[2]http://www.weather.gov.sg/climate-historical-daily/
[3]https://www.kaggle.com/datasets/shymammoth/singapore-city-geo-coordinates-more-reliable
[4]https://www.singstat.gov.sg/find-data/search-by-theme/population/geographic-distribution/latest-data
[5]https://beta.data.gov.sg/datasets?query=Waterbody&resultId=d_0b0792ae30cd6cce62e5ea55fc37860e

- *ggimage* for adding icons above the labels
- *sf* for working with spatial data
- *tibble* for creating and manipulating tibbles (data frames)
- *dplyr* for data manipulation
- *geojsonsf* for converting GeoJSON data to sf objects
- *scales* for formatting plot scales
- *viridis* for using color-blind friendly palettes
- *ggspatial* for adding north arrows and scale bars to spatial plots
- *leaflet* for interactive maps
- *stringr* for string manipulation
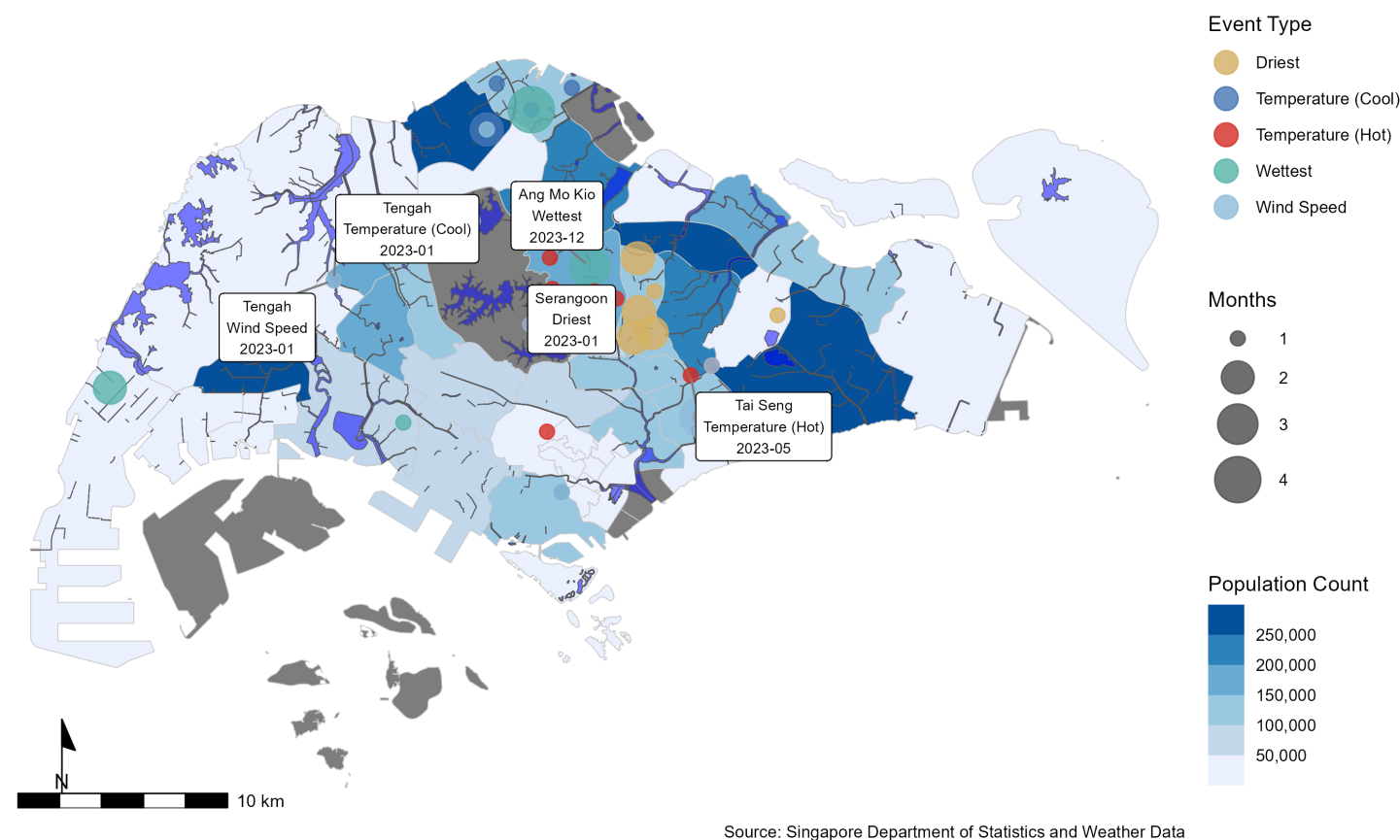- *rvest* for web scraping

Improved Visualization

Figure 3: Improved visualization of Weather Extremes in Singapore 2023

Further Suggestions for Interactivity

To further enhance our improved visualization we aim to enhance by implementing hover-over interactivity for the different estates in Singapore. Users can explore the different weather event statistics in 2023, along with the population numbers, by hovering over specific regions and clicking on them. Zoom and pan features can help facilitate exploration by providing more detailed views of different regions. Overall these interactions can make the visualization more interactive and insightful.

Conclusion

In conclusion, our visualization of weather extremes in Singapore for 2023 offers a comprehensive overview of the climatic conditions. Through clear and concise annotations, we highlighted significant weather events such as hottest day and driest months that affected Singapore due to the climate phenomenons. By using color-coded legends and incorporating data on environmental factors such as water bodies, our goal is to make the visualization more accessible. This approach helps users better understand how climate conditions in Singapore interact with the urban environment, providing a clearer picture of local weather patterns and their impact.