Visualizing Weather Extremes in Singapore 2023

Michael T. Gastner (Information and Communication Technologies)

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

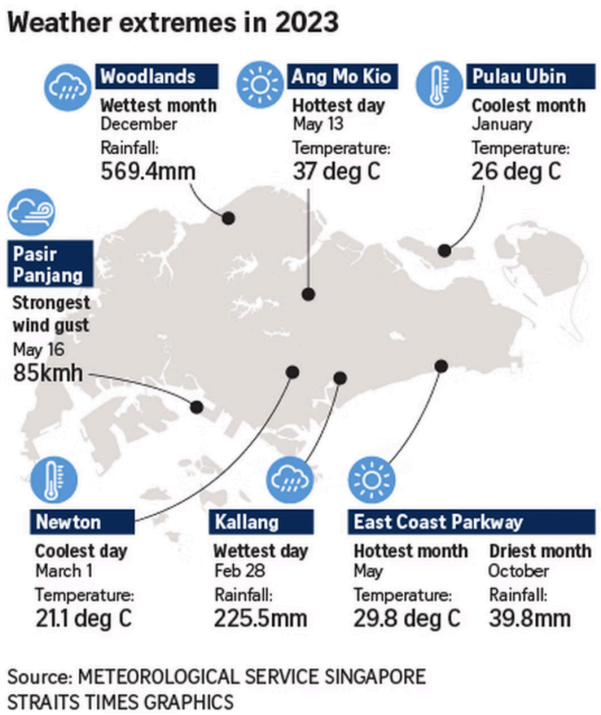

Figure 1: Weather Extremes in 2023, published by the The Straits Time.

[1]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

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

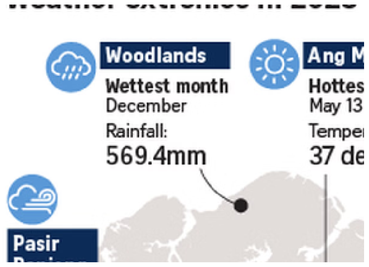

Figure 2: Zoomed-in screenshot of the weather condition label.

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. **Comparative Data:** We can include in the current details, comparative data, showing the weather details of the past year and of the respective year which contained the previous highest/lowest extremes if this year had any record breaking data. This can give context on whether these extremes are increasing, decreasing, or stable.
4. **Layered Related Data:** We can layer data related to weather conditions such as car accident occurrences relating to wet or dry weather, population density relating to relative temperature of region, etc.
5. **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 and data.gov.sg provide detailed weather statistics and real-time weather readings across Singapore, which can be accessed and used to replicate the visualisation we are interested in[2].

[2]http://www.weather.gov.sg/climate-historical-daily/

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
- *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

Improved Visualization

Further Suggestions for Interactivity

Conclusion

michael.gastner@singaporetech.edu.sg