

# Weather Data Analysis: Assessing Rainfall, Temperature, and Wind trends in Singapore

Freddie Tan Jr., Rachel Yee Rui Min, Ruosong Zhou  
Singapore Management University  
ISSS608 Visual Analytics Lab



## INTRODUCTION & OVERVIEW

Climate change has been a top priority issue in recent decades. Each year, climate change's impact has become more evident through rising sea levels, fluctuating temperatures, unpredictability of weather, and countless other effects that climate change has had on life.

As a part of addressing climate change, learning how to adapt society to the impact that it has created has become a priority for many governments in the world. For Singapore, a part of this effort is through Meteorological Service Singapore which collects and maintains national weather records.

## OBJECTIVES

Using the data collected from **Meteorological Service Singapore**, the team aims to do the following:

1. Reveal patterns and anomalies with past weather data.
2. Identify correlations between different effects of climate change.
3. Visualize the different effects of climate change to the different regions of Singapore.
4. Provide suggestions to addressing the impact of climate change to Singapore.

## Targeted Analysis:

- Rainfall: Average rainfall for each region within Singapore per year & Precipitation patterns
- Temperature: Average temperature of each region within Singapore per year & Temperature variations
- Wind Patterns: Direction and intensity of winds

## METHODOLOGY

### The Data

The dataset chosen for this project came from the Meteorological Service Singapore website. For specification, the years 2013 to 2023 will be studied, from the five main regions in Singapore: Central Region, East Region, North East Region, North Region and West Region. Each region is represented by a station where the weather data is collected from: Newton, Changi, Pulau Ubin, Admiralty, Jurong (West) in the same order as the areas mentioned previously.

### Data Wrangling

Since there were a total of 5 regions, over the span of 10 years, and 12 months in each year. There were a total of 600 files to be merged. After joining the data, three wrong data types were fixed to the appropriate types. Then, unwanted columns were deleted and the rest of the columns were renamed for better understanding.

### Missing Values

The data downloaded were csv files of monthly data for a specific region. Some of these dataset have numerous missing values in some of the columns, which was replaced with 'NA'.

### Tools

R programming was utilized to process the data, to perform statistical analysis, and to develop the web application that was published on Netlify (Quarto) and R Shiny.

## Final Variables

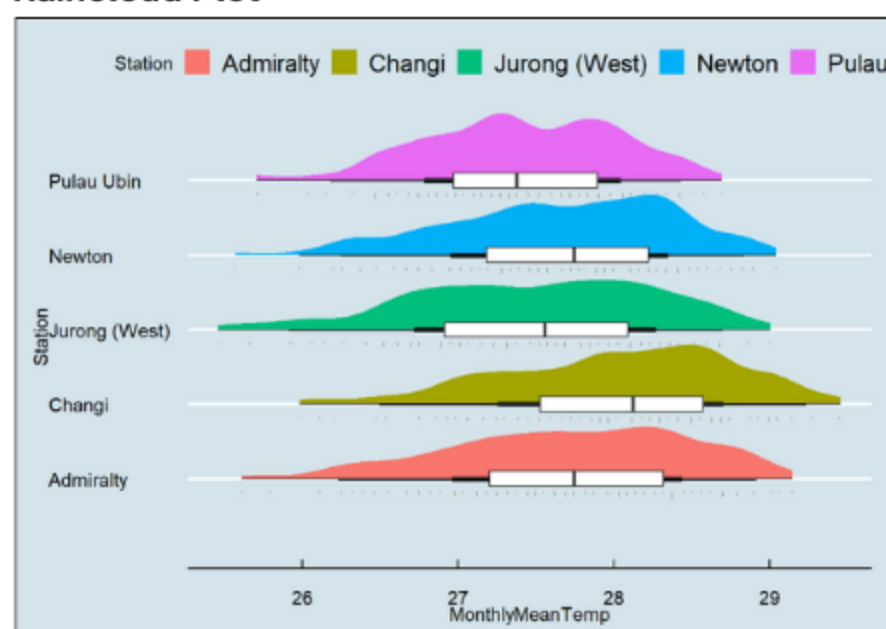


## Summary of Numerical Variables

Rainfall	MeanTemp	MaxTemp	MinTemp	MeanWind	MaxWind
Min.: 0.000	Min.: 22.20	Min.: 22.80	Min.: 20.00	Min.: 0.400	Min.: 8.30
1st Qu.: 0.000	1st Qu.: 26.90	1st Qu.: 30.90	1st Qu.: 24.10	1st Qu.: 5.800	1st Qu.: 27.00
Median: 0.200	Median: 27.70	Median: 32.00	Median: 25.00	Median: 7.200	Median: 31.70
Mean: 6.327	Mean: 27.66	Mean: 31.75	Mean: 25.01	Mean: 7.984	Mean: 32.77
3rd Qu.: 6.000	3rd Qu.: 28.50	3rd Qu.: 32.90	3rd Qu.: 25.90	3rd Qu.: 9.400	3rd Qu.: 37.40
Max.: 210.600	Max.: 30.80	Max.: 36.80	Max.: 29.00	Max.: 31.300	Max.: 105.50
NA's: 460	NA's: 649	NA's: 587	NA's: 587	NA's: 800	NA's: 796

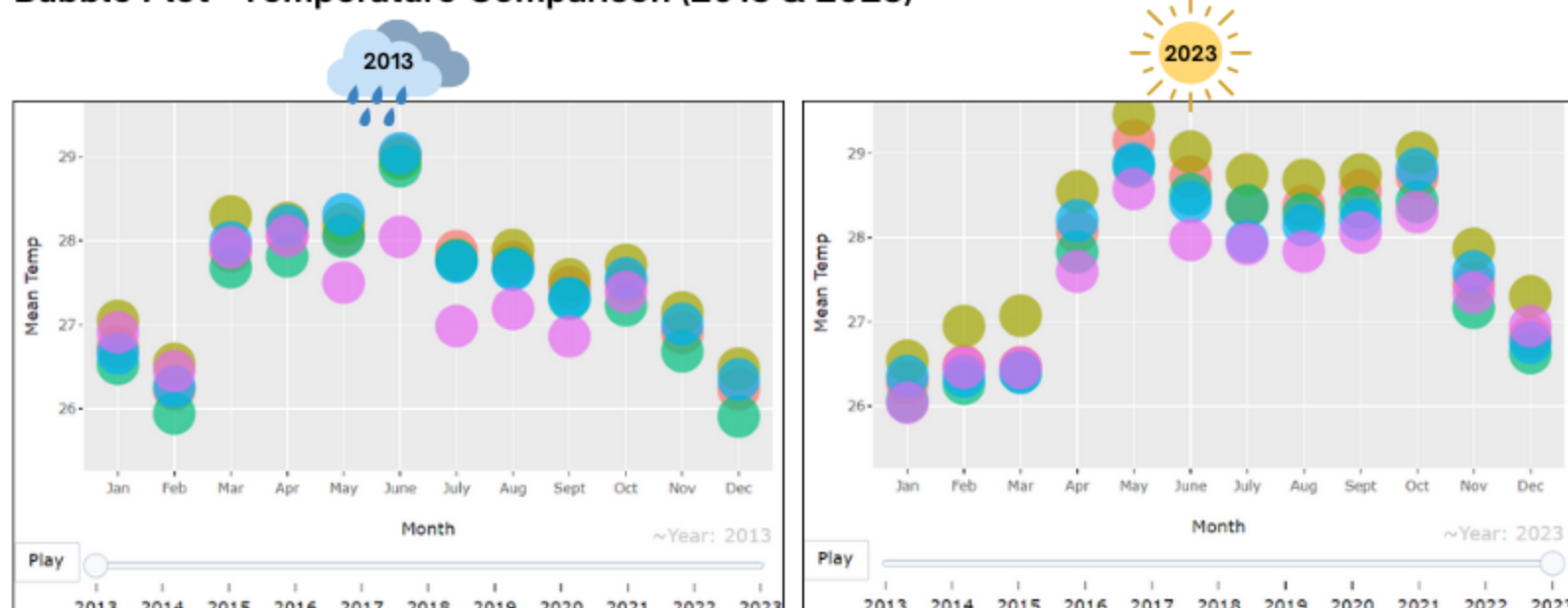
## TEMPERATURE

### Raincloud Plot

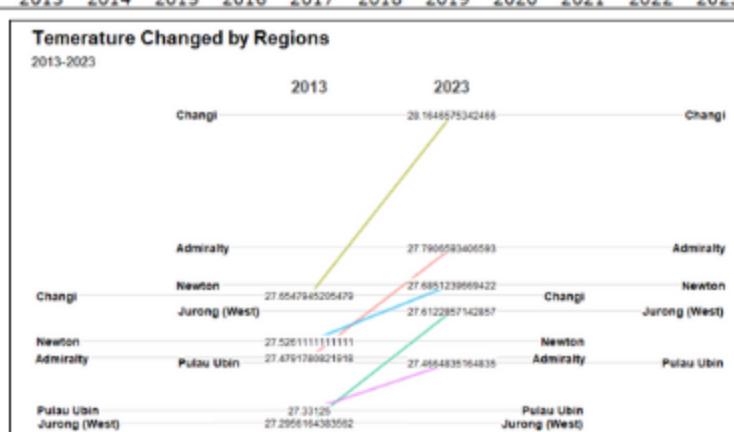


The Raincloud Plot reveals a subtle but noticeable trend: Changi station, which is situated in the eastern region of Singapore, exhibits a marginally higher mean temperature compared to other areas. This suggests that Changi experiences a disproportionately higher number of warmer days compared to other areas. In contrast, the temperature in other regions seems to be relatively consistent throughout the years. Notably, with Pulau Ubin, nestled in the Northeast region, stands out for its cooler days compared to the surrounding areas.

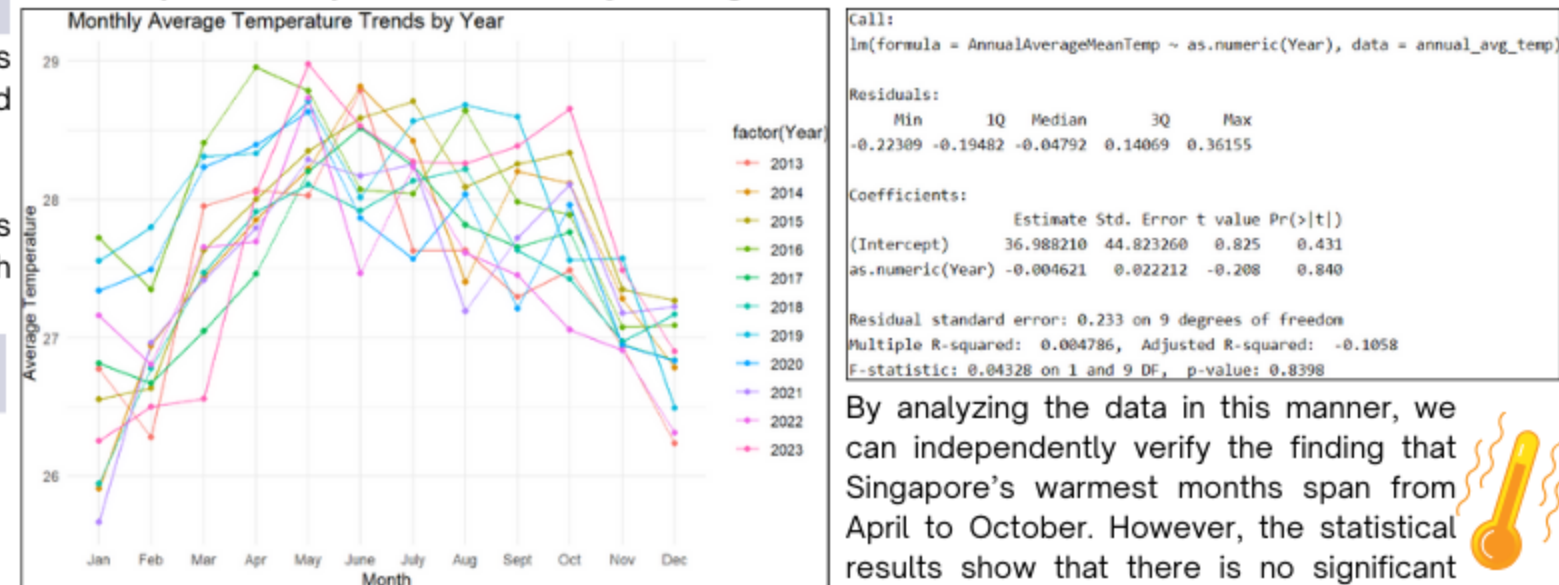
## Bubble Plot - Temperature Comparison (2013 & 2023)



Examining the data solely from 2013 to 2023, every station exhibits a discernible upward trend, signaling an overall rise in average temperatures over the previous decade. Based on this analysis, there doesn't appear to be a significant trend in the annual average temperature over the years. It can be inferred that relying solely on temperature data from the past decade to predict future temperatures will likely not result in an increase of 1.4 to 4.6 degrees, as previously claimed by the Ministry of Sustainability and the Environment.



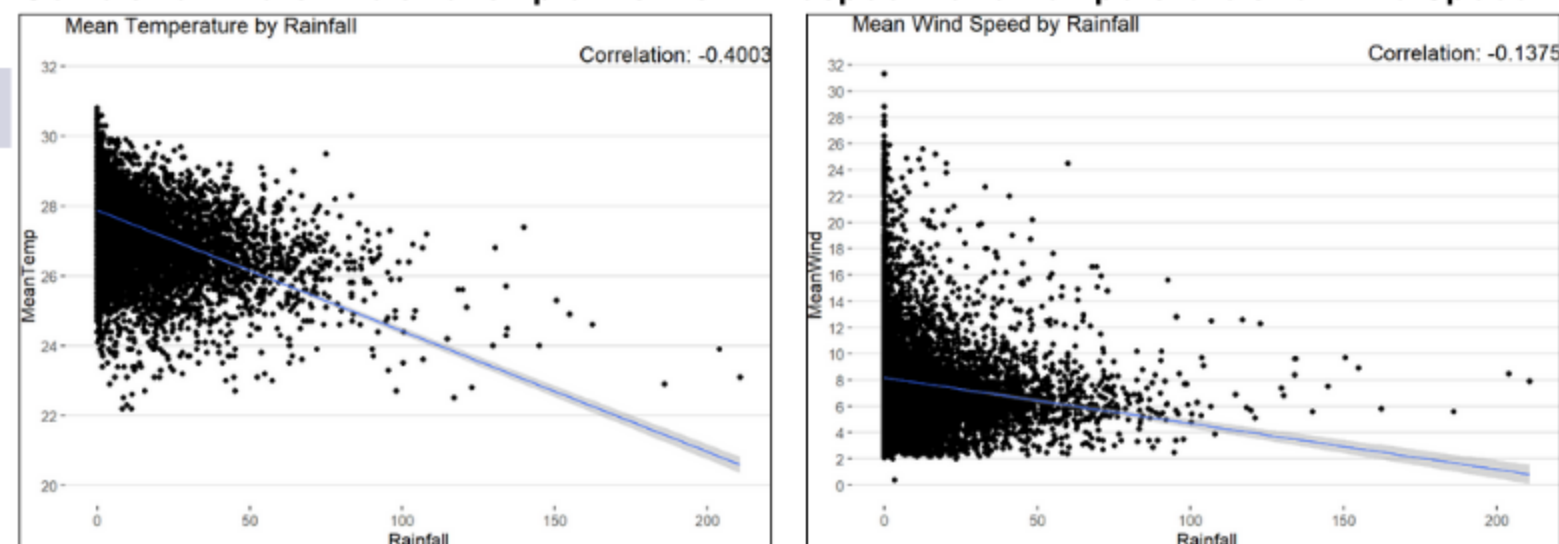
## Line Graph of Temperature monthly through 2013 - 2023



By analyzing the data in this manner, we can independently verify the finding that Singapore's warmest months span from April to October. However, the statistical results show that there is no significant trend in temperature over the years.

## RAINFALL

### Correlation Plots - Relationship of Rainfall in respective to Temperature and Wind Speed

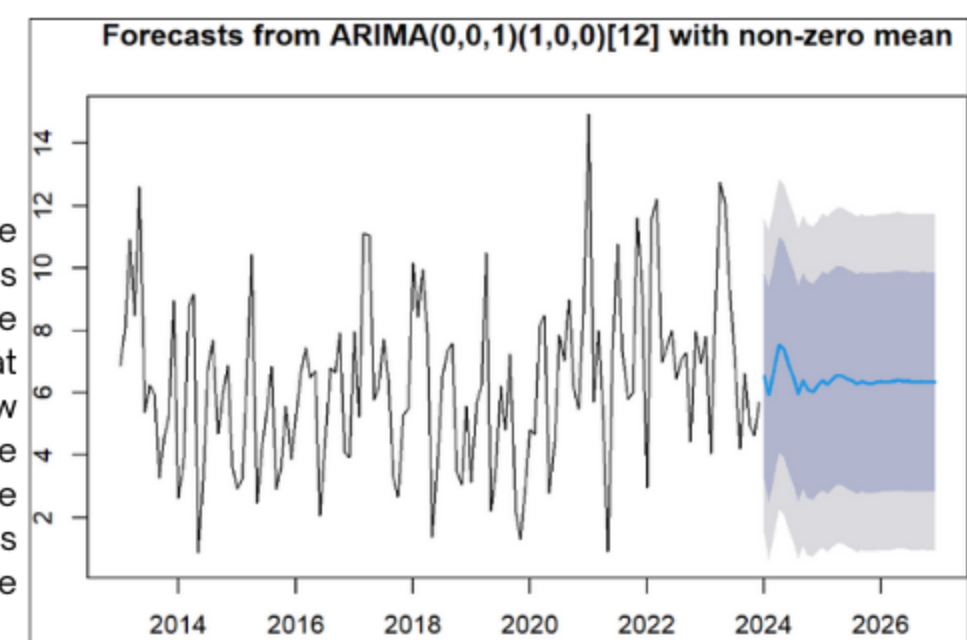


As observed, there is a moderate association between the amount of rainfall and the temperature observed for the day. There is a pattern that shows that the more rainfall occurs, the lower the temperature appears to be. Meanwhile for wind speed, there does not appear to be any association between the wind speed and the observed amount of rainfall.

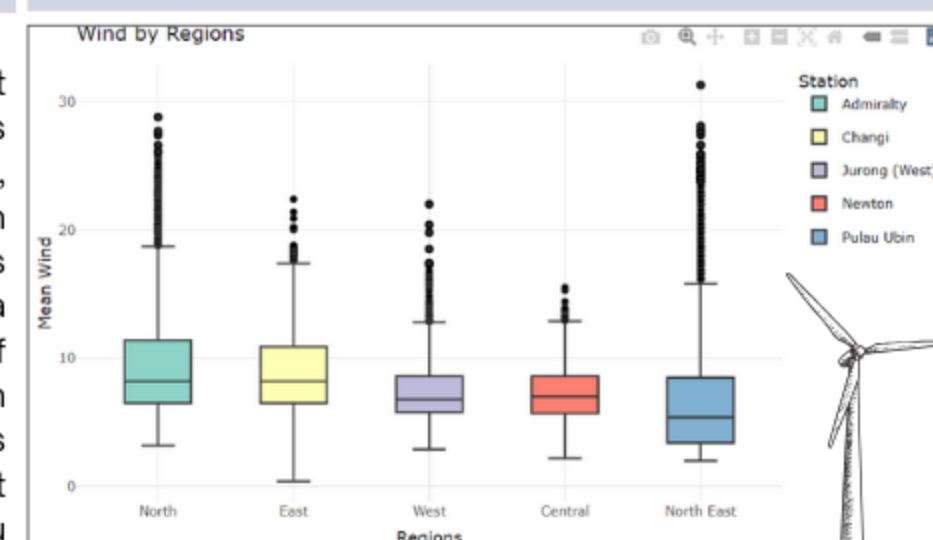
### Predictive Analysis



This is the predicted trend for the rainfall in Singapore. The model has a large deviation due to the inconsistent weather patterns that have been observed the past few years. In truth, this is very well in line with the concerns regarding climate change as a part of the results is that weather patterns become more erratic and unpredictable.



## WIND



### Boxplot - Comparison by Regions

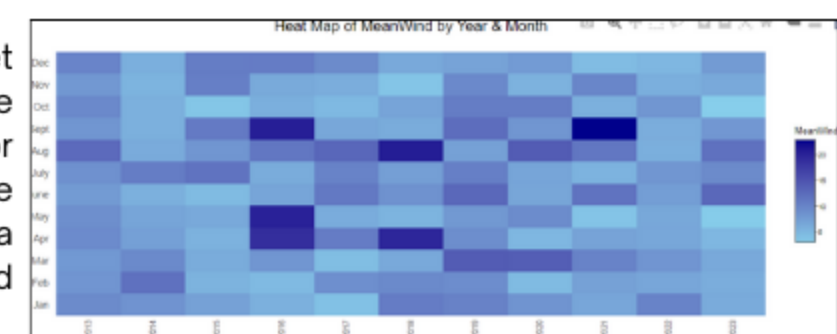
From the results shown, the areas ranging from lowest average wind speed to highest go as follows respectively: North-East, West, Central, and North and East, with the following median values:

- North: 8.20
- East: 8.20
- West: 6.80
- Central: 7.00
- North-East: 5.40



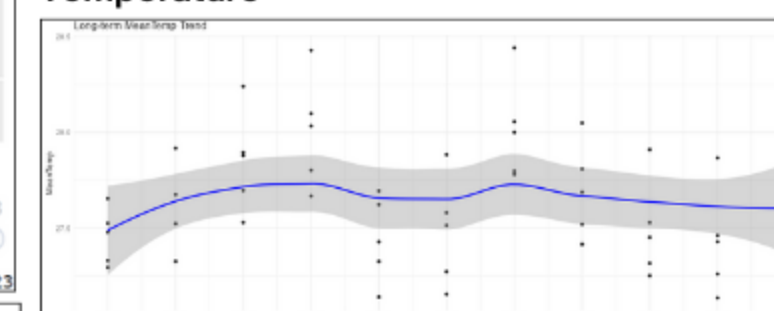
### Heatmap

Like what was mentioned in the pamphlet from Ministry of Sustainability and the Environment, there are no clear trends for wind speed as it is dependent on the environment. The heatmap does not show a clear or significant result for wind speed throughout the years.

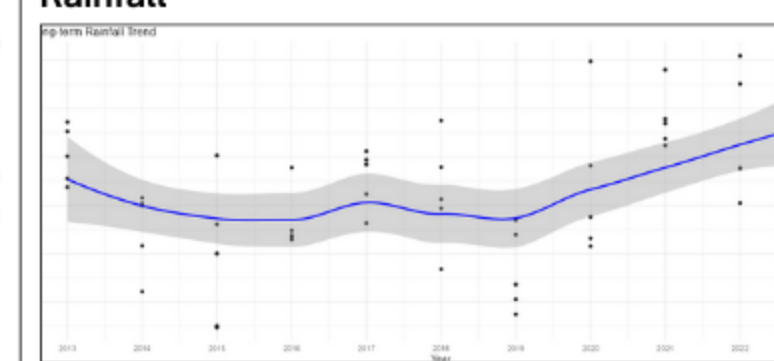


## CONCLUSION

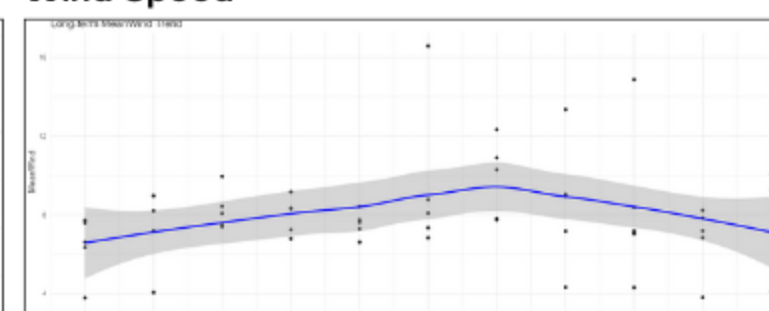
### Temperature



### Rainfall



### Wind Speed



**Temperature** did rise over the years, however it was a very small increase, and more data would be needed to predict the temperature trend for future years. There is also no clear trend for **wind speeds**, it is highly likely to be depends on the environment. For **rainfall**, it seems to have a clearer trend, with an increase in rainfall throughout the years. Nonetheless, weather patterns seem to be more erratic and unpredictable.