

# Are Our Floods Getting Out Of Control?

A visualisation of Singapore's weather data to improve flood mitigation

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## Project 1 Presentation

DSIF-SG-9:

Ho Kit Fai

Sherena Lim

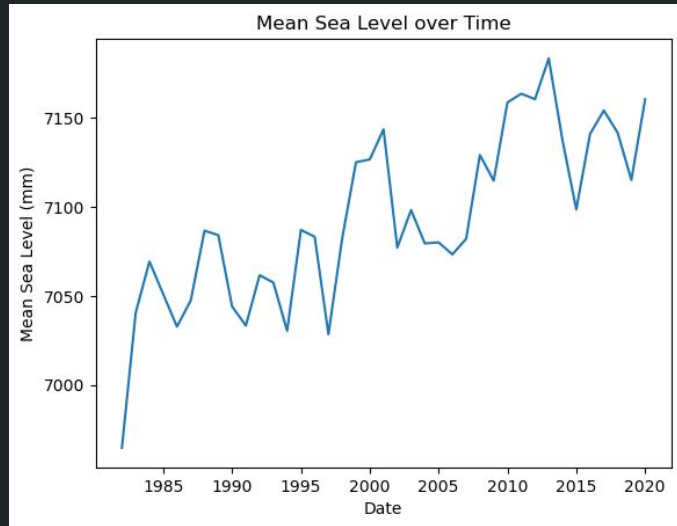
Tan Song Kai

# Agenda

- Background
- Problem Statement
- Visualising Singapore's weather
- Implications of Erratic Weather
- Summary of Analysis
- Conclusions & Recommendations
- Q&A

# Background

- Singapore's mean sea level: annual increase of 3-4 mm
- Global average surface temperatures are expected to increase 1.3°C-5.7°C
- More evaporation, more rainfall



## Measures against rising sea level

- External defence: coastal protection
- Internal defence: drainage systems, water catchment facilities

## Limitations of internal mitigations to manage floods

- Drainage sizing
- Rainfall unpredictability resulting in flash floods



## Consequences

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graph TD; A[Consequences] --> B[Direct Cost]; A --> C[Indirect Cost]; B --> B1[- Flood Damages]; B --> B2[- Accidents & Injuries]; B --> B3[- Environment & Biodiversity]; C --> C1[- Business & Tourism]; C --> C2[- Productivity]; C --> C3[- Food Prices]; C --> C4[- Property Values]; C --> C5[- Quality of Life];
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### Direct Cost

- Flood Damages
- Accidents & Injuries
- Environment & Biodiversity

### Indirect Cost

- Business & Tourism
- Productivity
- Food Prices
- Property Values
- Quality of Life

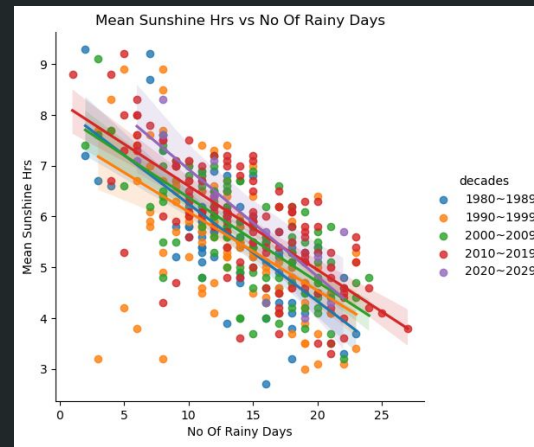
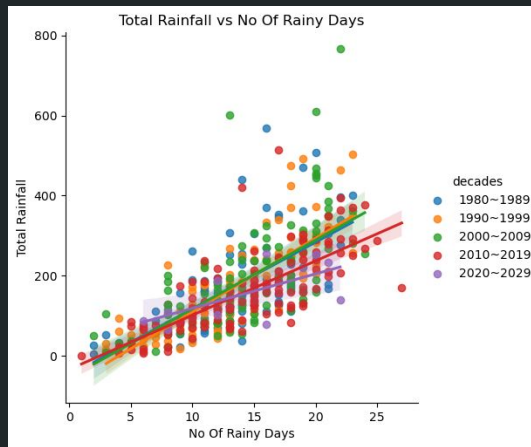
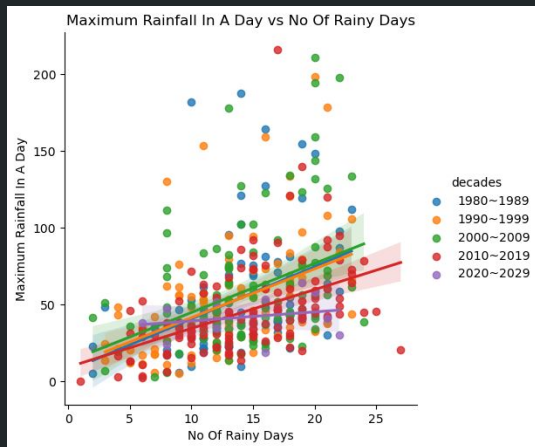
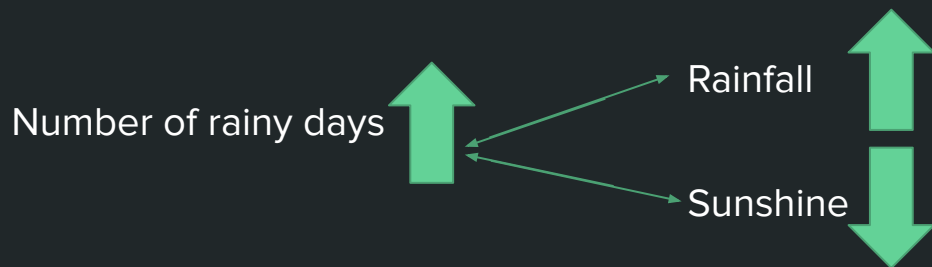
# Problem Statement

To examine the relationship between Singapore's mean sea level and its weather conditions to mitigate floods effectively

# Visualising Singapore's Weather

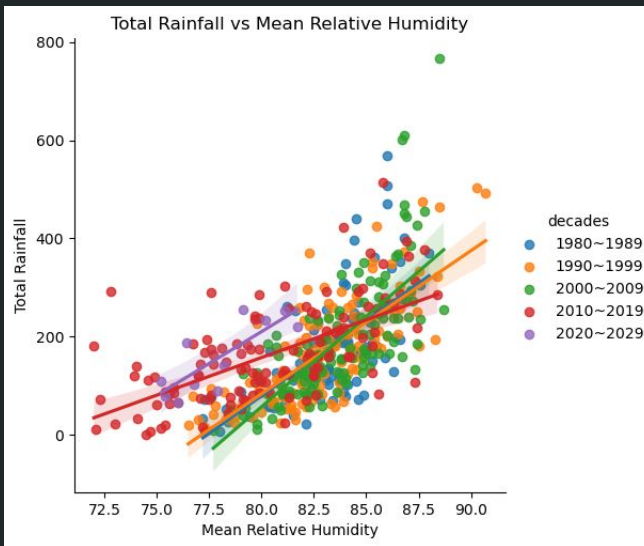
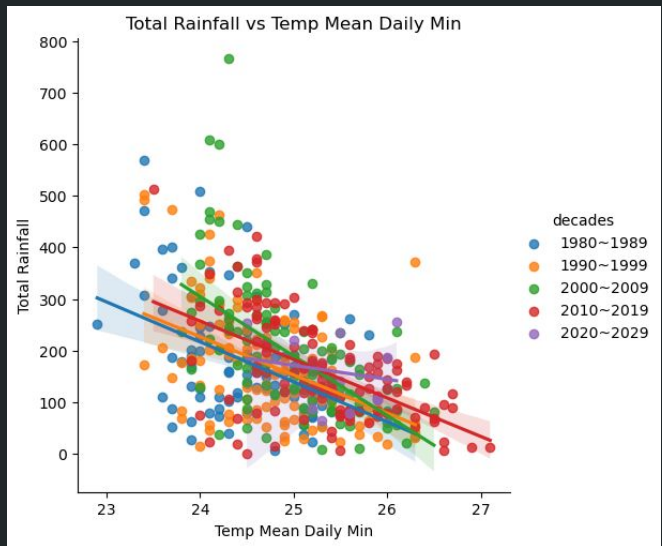
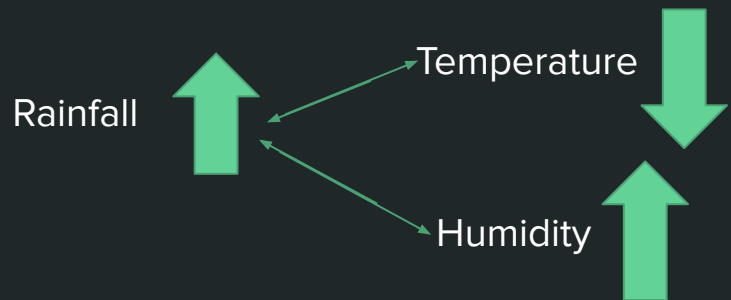
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# Observations



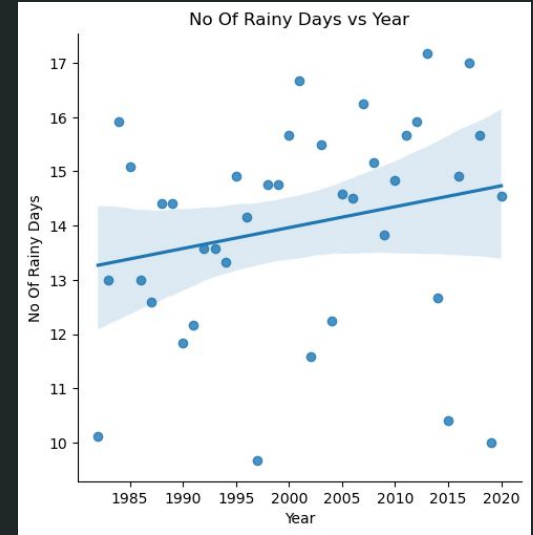
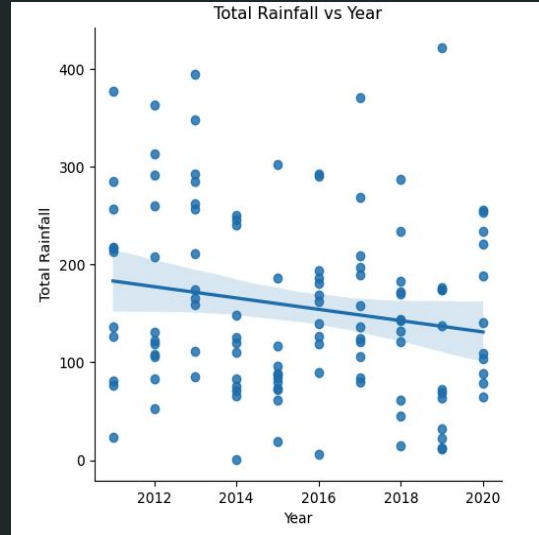
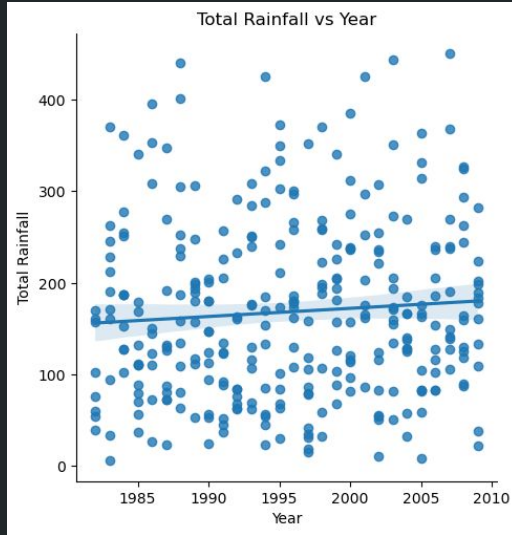


# Observations



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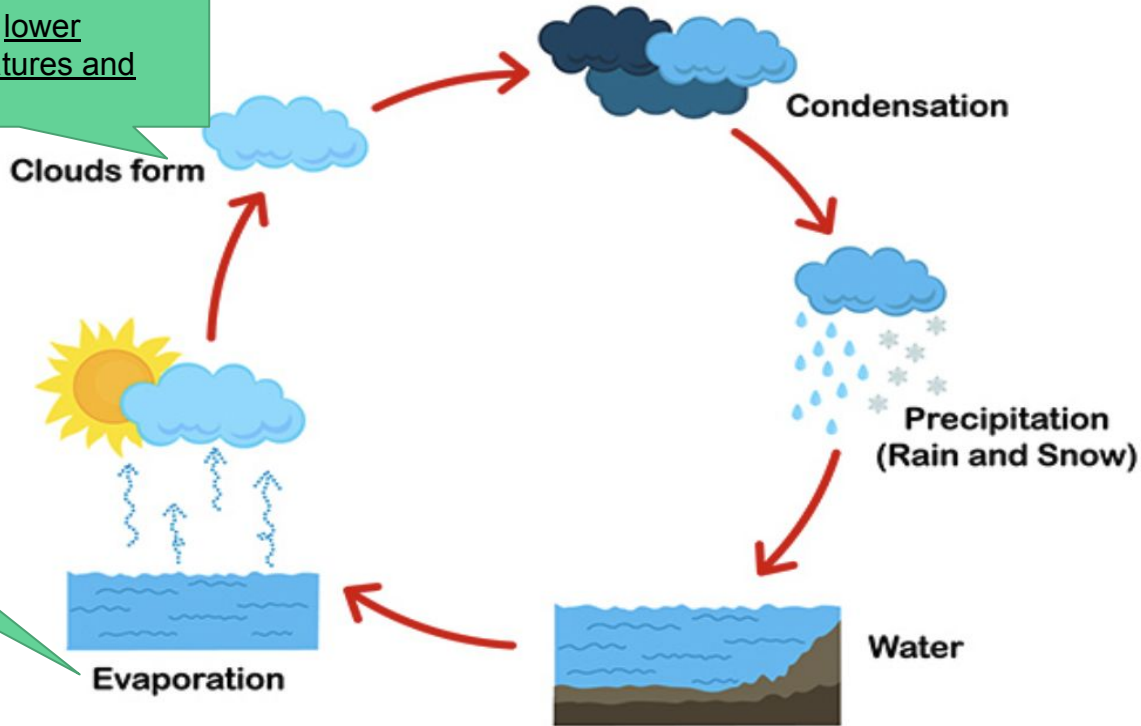
- Gradual increase from 1982 - 2010
- However downward trend observed past 10 years
- Steady increase in number of rainy days



# Before the Bad News: The Water Cycle Speeding Up

Cloud formation reflects solar and light energy from the sun, resulting in lower surface temperatures and less sunshine

Water bodies trap heat and this speeds up evaporation, leading to increased relative humidity

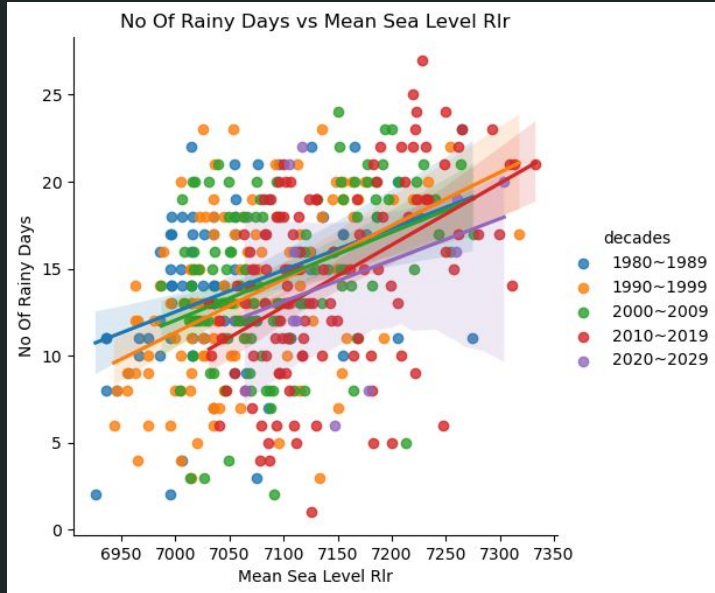


# Implications of Erratic Weather

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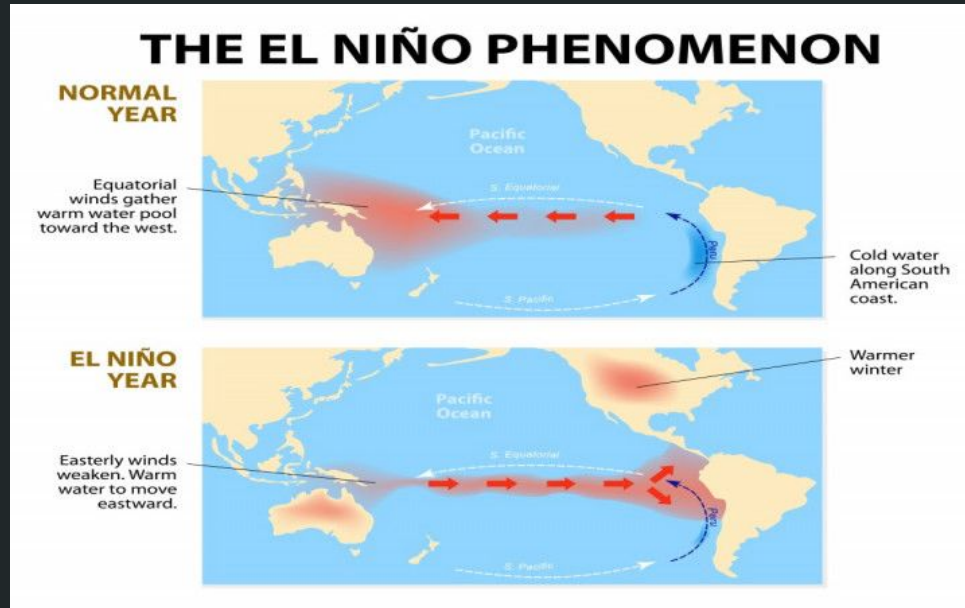
# Relationship between Mean Sea Level and No of Rainy Days

- Positive correlation between mean sea level rise and number of rainy days.
- Throughout the decades, this had been consistent. This is in line with the earlier observation of number of rainy days increasing over the years.
- Coupled with the water cycle, we can now see that higher mean sea level results in a larger volume of water to evaporate and promote cloud formation



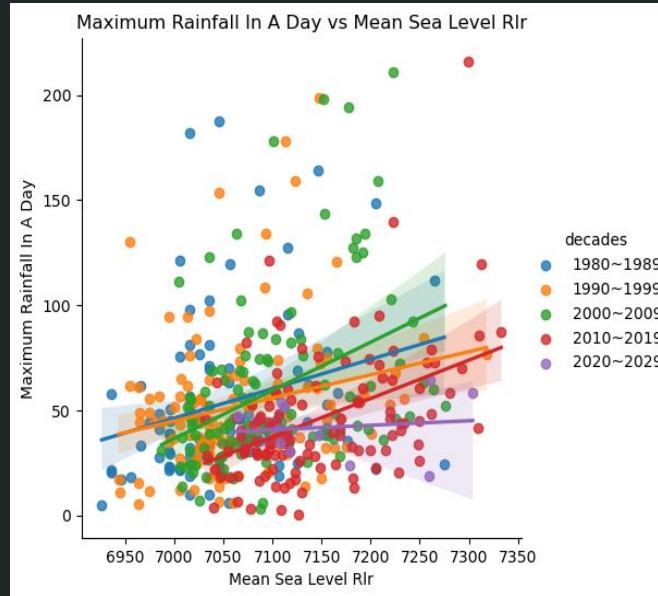
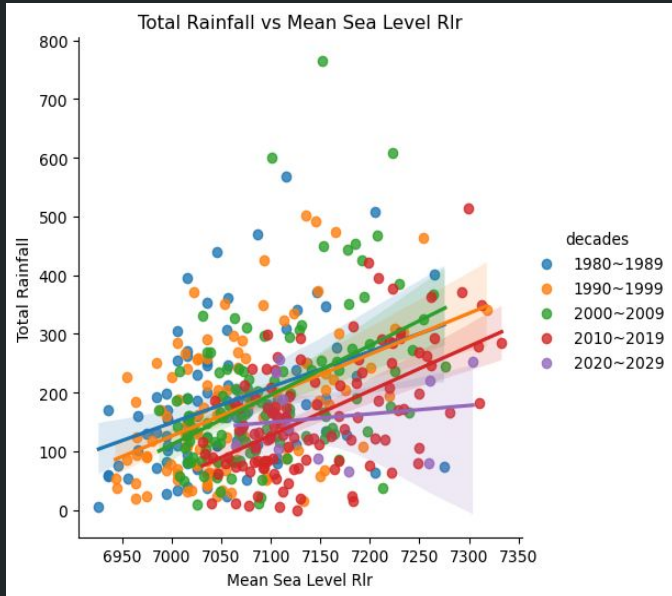
# New Terms - El Nino

- There is a counter clockwise ocean current swirl
- During El Nino years, the warm water currents counter the swirl, taking away raincloud from Asia, leaving us drier
- El Nino can last for 2~7 years



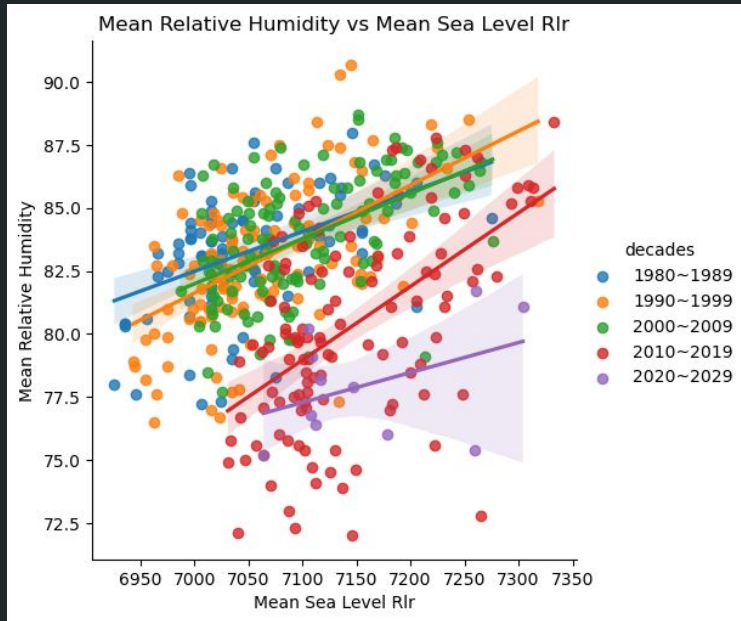
# Relationship between Mean Sea Level and Rainfall

- Positive correlation between mean sea level rise and rainfall
- Up to 2010s, the pattern has been consistent. With the disruption by the El Nino in 2015-2016, the general in the past decade had fallen, but we expect this to be temporary
- When the El Nino's effects wear off, we can anticipate a continue rise in rainfall (erratic), which is inline with the rainfall data over the years



# Relationship between Mean Sea Level and Humidity

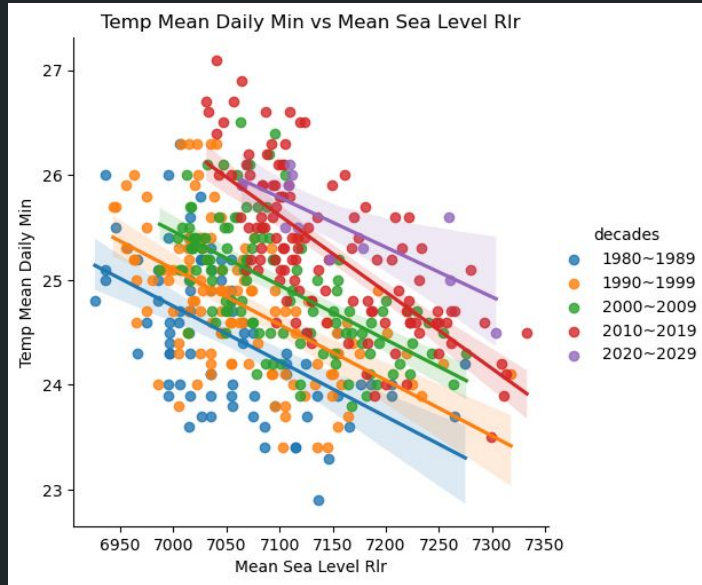
- Positive correlation between mean sea level rise and humidity
- Up to 2010s, the pattern has been consistent. With the disruption by the El Nino in 2015-2016, the humidity in the past decade had fallen, but we expect this to be temporary
- When the El Nino's effects wear off, we can anticipate a continue rise in humidity, which promotes cloud formation and eventual rain





# Relationship between Mean Sea Level and Surface Temperature

- Negative correlation between mean sea level rise and surface temperature
- We can note that with global warming, the daily minimum temperatures had risen over time
- However, with the combined effects of the humidity, and increasing number of rainy days, it is not unreasonable to expect higher rainfall in the future



## Analysis Summary

- Rising mean sea levels gels well with Singapore's weather data.
- From the water cycle, rising mean sea levels contribute to a higher volume of seawater, which has excellent heat storage capacity.
- This increase in temperature promotes evaporation and cloud formation, eventually resulting in rainfall.

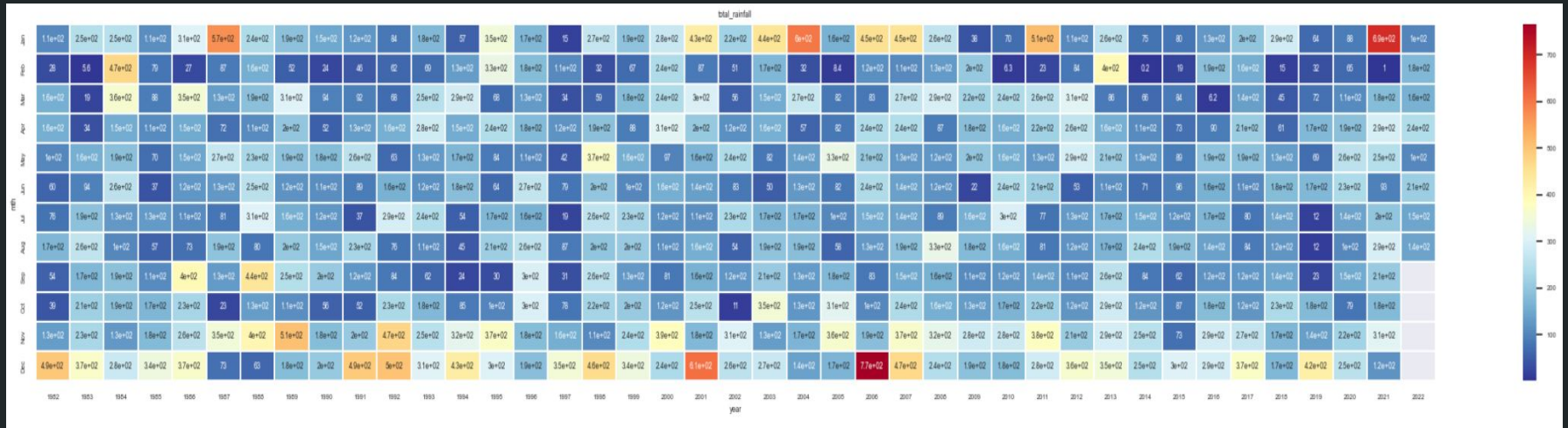
# Conclusions & Recommendations

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# Conclusion

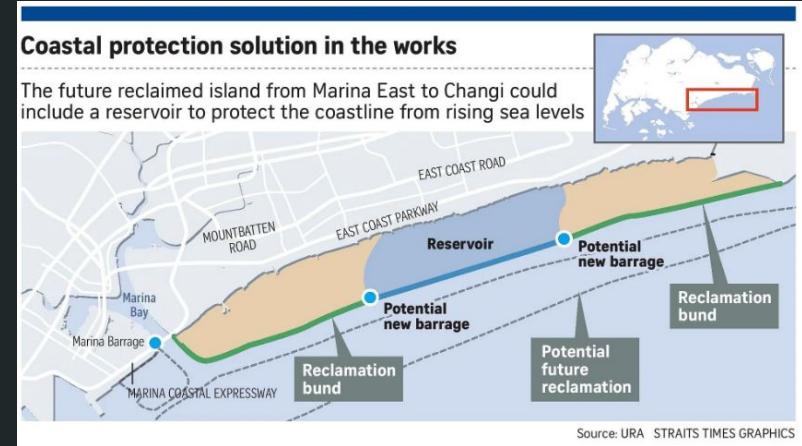
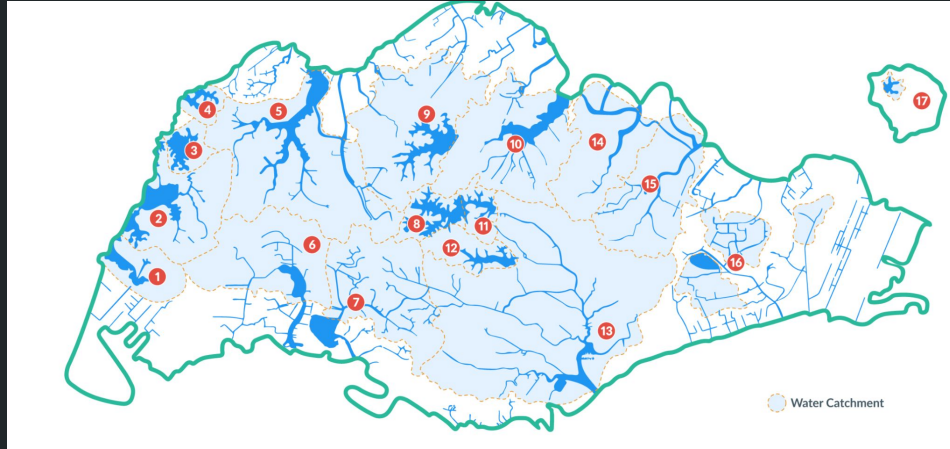
- Singapore is able to address rising mean sea levels through strengthening our external defences, such as the use of seawalls.
- However, this also implies that rainfall will increase over the years and eventually overwhelm our internal control measures.
- Therefore, more proactive measures need to be taken to bolster our internal defences to mitigate flooding.

# Recommendation



- Utilising rainfall data from December-January timeframe (coinciding with the North East Monsoon) to size up our internal defences (storm drain, water catchment, etc)
- Drier months (eg. February) can be used for periodic maintenance of the internal defences

# Recommendation



We need to increase the capacity of our water catchment:

- Enlarging existing water catchment (such as Seletar and Peirce) thru land acquisition of land nearby
- Speed up the construction of the Long Island along East Coast Park

# Q&A

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