

Understanding Future Climate Extremes for a Climate-resilient Singapore

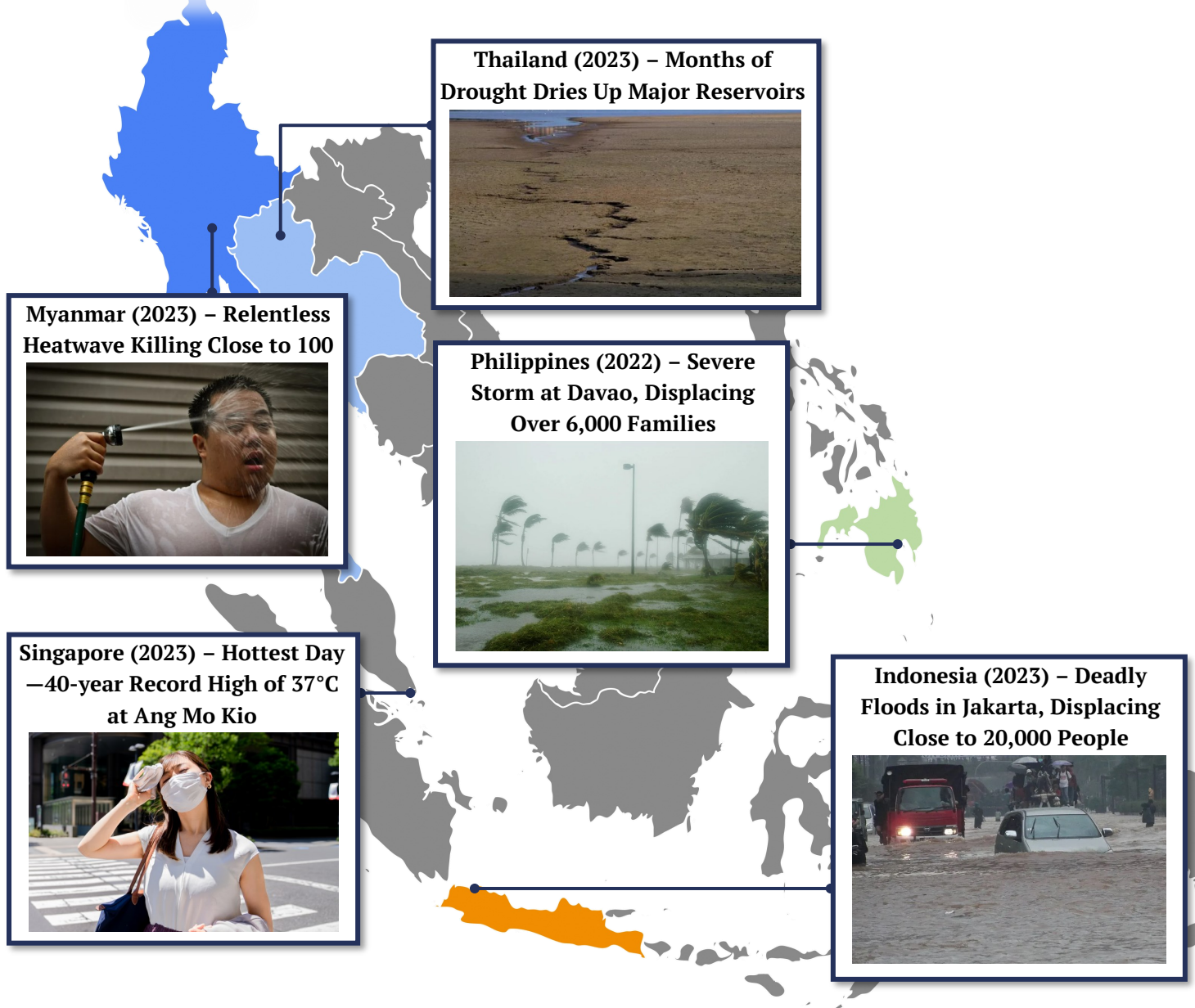
To further advance our understanding of climate extremes in Singapore and the Southeast Asia region, the Centre for Climate Research Singapore (CCRS) is carrying out the Third National Climate Change Study (V3) to produce projections of extreme events, informing climate adaptation strategies for a climate-resilient Singapore.



**METEOROLOGICAL
SERVICE
SINGAPORE**
Centre for Climate Research Singapore

Extreme Climate Events

Extreme climate events are those that occur very rarely based on historical records. These events, such as unusually heavy rainfall, droughts and heatwaves, can have severe impact on human health, and increased risk to habitats and other infrastructure.



However, what constitutes an extreme climate event can differ from place to place. For instance, a total monthly rainfall of 50mm is considered extremely dry in Singapore, but the same amount of rainfall in a desert would be considered extremely wet.

How is an extreme event for a particular location defined?

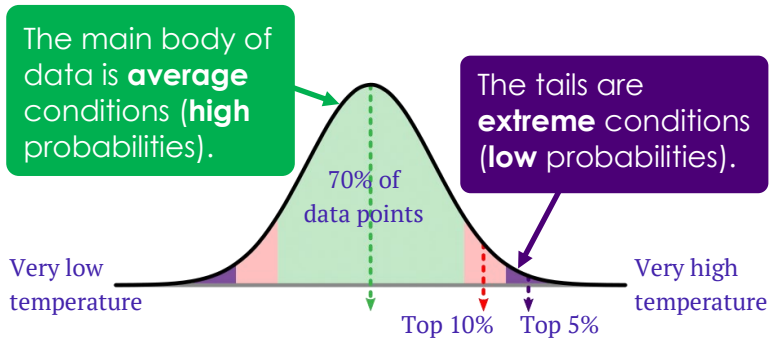


Defining and Describing Extreme Climate Events

The following explains how extreme climate events are defined and measured.

1 Percentile – Describing how far away an event is from average conditions

- A “bell curve” is constructed by arranging historical data (e.g. daily temperature) from lowest and highest, and recording the number of occurrences (frequency).
- The 95th percentile would mark the temperature below which 95% of days are cooler, and above which 5% of days are hotter.
- A temperature is said to be extreme when it is in the upper or lower 5% or 10% of the “bell curve” of temperatures recorded.



2 Return Period – Describing when an event occurs again

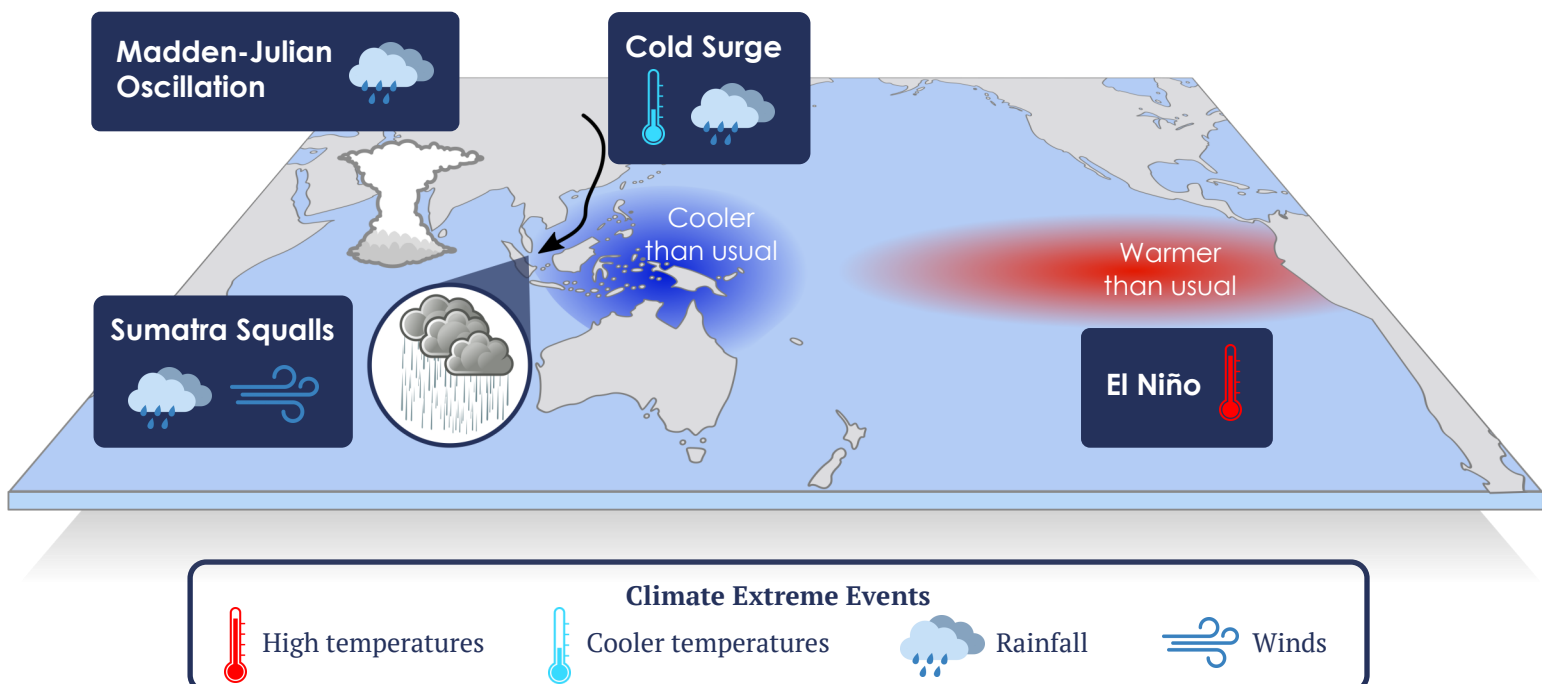
- Long data records are used to determine the return period of extreme climate events.
- With a warming climate, more unforeseen extreme events are projected, as climate change decreases the return period of these events.
- For example, an extreme event with a return period of 50 years is said to have the chance of 2% occurring each year. Under climate change, a flood with 50-year return period could now have a 10-year return period in future.

3 Climate Extreme Indices – Assessing climate extremes under future warming

- Standard climate indices are used to characterise one or several aspects of an extreme climate event.
- They are used to describe changes in extreme climate events from historical to future climate scenarios.
- Most climate extreme indices are defined around rainfall and temperature exceeding certain thresholds. Some examples include:
 - TXx: Highest temperature of the month
 - Rx1day: Maximum 1-day total rainfall of the year
 - R95p: Annual total rainfall from days with rainfall above the 95th percentile of daily rainfall records

Climate Drivers and Extreme Climate Events

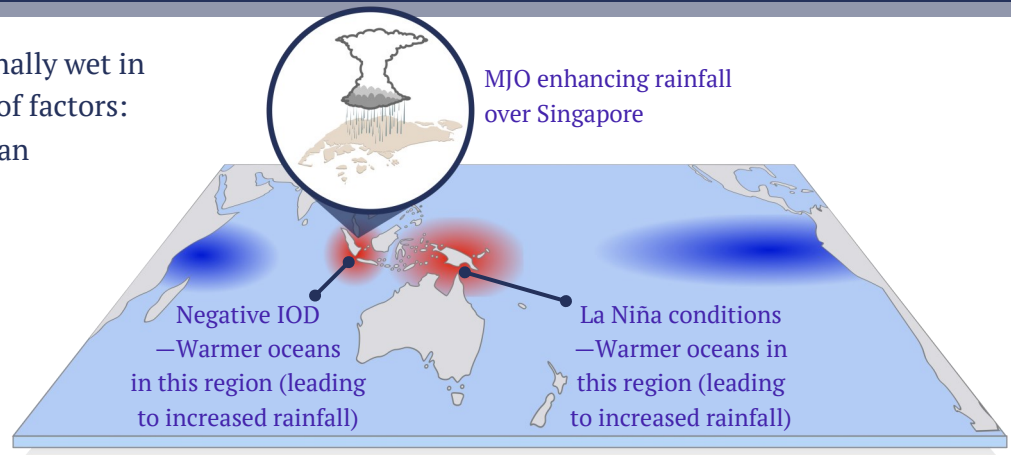
The occurrence of extreme climate events in Singapore is often influenced by various climate drivers¹.



¹ For a complete overview of climate drivers in the region, visit <https://go.gov.sg/mc-climate-drivers>.





For example, Aug 2021 was exceptionally wet in Singapore, caused by a combination of factors:

- Negative phase of the Indian Ocean Dipole (IOD)
- Developing La Niña conditions
- Passage of the Madden-Julian Oscillation (MJO)



Projections of Extreme Climate Events over Singapore and the Region

- Singapore’s Third National Climate Change Study (V3) conducted by the Centre for Climate Research Singapore (CCRS) provides projections of climate variables such as rainfall, temperature, winds and relative humidity until the end of the century.
- V3 products include derived metrics such as climate extreme indices for three climate change scenarios (i.e. SSP1-2.6, SSP2-4.5 and SSP5-8.5). These **metrics** focus primarily on extreme temperatures, winds, and wet and dry extremes, using standard international extreme indices¹. Some examples are:

 <p>Extreme Temperatures</p> <ul style="list-style-type: none"> – Highest temperature of the year – Number of warm days² and heatwave days per year – Wet bulb globe temperature 	 <p>Dry Extremes</p> <ul style="list-style-type: none"> – Maximum dry spell length per month – Number of droughts per year – Maximum drought length per year
 <p>Winds</p> <ul style="list-style-type: none"> – Maximum wind speed of the year (at 10m altitude) – Maximum wind gust of the year (at 10m altitude) 	 <p>Wet Extremes</p> <ul style="list-style-type: none"> – Maximum 1-day total rainfall of the year – Maximum wet spell length per month

- V3 delivery also includes analysis of compound extreme events and a comparison to historical extremes.
- Through informing adaptation planning on local and regional scales, these metrics can enable better management of the risks of future climate extreme events and increase climate resilience in the region.

¹ For more information on international extreme indices, visit www.Climdex.org or the [Expert Team on Sector-Specific Climate Indices \(ET-SCI\) website](#).

² A warm day is defined as the day when the daily maximum temperature is higher than 34.1°C.

Image credit: Page 2, man spraying water © Guian Bolisay / [CC BY-SA 2.0](#)

Centre for Climate Research Singapore

A research centre under the Meteorological Service Singapore and part of the National Environment Agency. It was officially launched in March 2013, with the vision to be a world leading centre in tropical climate and weather research focusing on the Southeast Asia region.

 36 Kim Chuan Road, Singapore 537054

 NEA_CCRS_Engage@nea.gov.sg

 ccrs.weather.gov.sg

 [linkedin.com/showcase/ccrs-mss/](https://www.linkedin.com/showcase/ccrs-mss/)