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LATEST CLIMATE PROJECTIONS FOR SINGAPORE SHOW INTENSIFYING URBAN HEAT AND MORE WET & DRY EXTREMES

Singapore's Third National Climate Change Study (V3) presents the world's highest resolution climate projections for Southeast Asia based on the IPCC 6th Assessment Report

Singapore, 05 January 2024 – The Centre for Climate Research Singapore (CCRS), under the Meteorological Service Singapore, has released the findings of the Third National Climate Change Study (V3[1]) today. V3 projects higher temperatures, more wet and dry extremes, and accelerating increase in mean sea levels for Singapore and Southeast Asia by the end of the century. This is consistent with the findings of the Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report (AR6)[2].

2 V3 updates Singapore's national climate change projections from the previous study (V2) released by CCRS in 2015. Based on a carefully selected set of global climate models from IPCC AR6, V3 downscales[3] the projections to higher resolutions of 8km over Southeast Asia and 2km over Singapore using CCRS' customised Regional Climate Model. Compared to V2, the V3 projections incorporate improved representations and a wider range of physical processes in the global climate system, enabling more accurate simulation of our regional climate on a finer scale.

3 V3 uses three projected global socio-economic pathways affecting greenhouse gas emission levels to explore the possible range of climate outcomes for Singapore and the surrounding region by end century. These correspond to the shared socio-economic pathways (SSPs)[4] used in the IPCC AR6. The low emissions scenario (SSP1-2.6) reflects a shift to sustainable development pathways with net zero targets achieved after 2050 while the high emissions scenario (SSP5-8.5) is driven by energy intensive, fossil fuel-based development. The medium emissions scenario (SSP2-4.5) takes a middle-of-the-road pathway where historical patterns of development continue throughout this century.

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[1] Key findings of the V3 study are summarised in Annex A. Detailed results can be found in the V3 Stakeholder and Technical reports at http://ccrs.weather.gov.sg/, and the V3 data visualisation portal (http://www.mss-int.sg/V3-climate-projections)

[2] Information on the IPCC, working groups and the assessment reports is available at https://www.ipcc.ch.

[3] Global climate models are run at a typical spatial resolution of 150km and do not show the variations in climate change projections at a more localised level.

[4] More information on the SSP scenarios is available at https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change/.

Very Hot Days and Warm Nights the New Normal by End Century

4 Consistent with earlier projections, Singapore is expected to become warmer, with annual mean temperatures rising between 0.6 and 5 degrees Celsius by end century. Singapore's annual mean temperatures, which increased at a rate of 0.24 degrees Celsius per decade in the past 40 years, is projected to rise to 0.55 degrees Celsius per decade by end century under the high emissions scenario.

5 Very hot days will become more frequent. Singapore experienced daily maximum temperatures exceeding 35 degrees Celsius[5] 21.4 days per year on average in the last 40 years. By end century, we will see between 41 and 351 days per year on average of such high daily maximum temperatures. More warm nights where temperatures exceed 26.3 degrees Celsius are also projected. From an average of 76 nights per year in the last 40 years, Singapore could experience such warm nights most nights in the year by end century.

Rainfall Extremes to Intensify, Dry Periods to Get Drier

6 Singapore's rainfall is highly variable at seasonal time scales. By the end of century, total rainfall during the southwest monsoon dry season of June-through-August could fall significantly below the historical low of 314 mm (recorded in 1997) around once every three years. For the northeast monsoon wet season of November-through-January, the corresponding seasonal total rainfall is projected to exceed the historical high of 1507 mm (recorded in 2006) occasionally.

7 Extreme daily rainfall[6] is projected to increase across all seasons, with increases ranging from around 6 to 92 per cent in the inter-monsoon months of April and May. On the other hand, dry spells[7] could be more frequent and last longer, with Singapore experiencing on average one dry spell every 10 to 60 months by end of century.

Mean Sea Level to Rise

8 The mean sea level around Singapore is projected to rise by 0.23m to 1.15m by end century, and by up to around 2m by 2150 under the high emissions scenario. This increase from the previous V2 projections (around 1m by end century) is primarily due to a better understanding of the contribution of the melting of the Antarctic ice sheets to global sea levels.

Staying Resilient in The Face of Climate Change

9 Singapore's future climate depends on the world's shared socio-economic pathways. All countries will have to act collectively to fulfil their net zero commitments. Singapore is doing our part, with the Singapore Green Plan. We are committed to reach net-zero carbon by 2050.

10 In addition, the Government takes a proactive approach not just in mitigation, but also in adaptation planning to ensure that we are prepared for the impacts of climate change. The Government will take into account the range of possible climate outcomes, including the high emissions pathway, in Singapore's adaptation plans to ensure that we remain climate resilient. Details of the Government's current climate adaptation efforts can be found in Annex B.

11 MSS will also be sharing the V3 data with ASEAN Member States at a later stage. In addition, MSS will be collaborating with international entities and the wider scientific community to undertake joint research using V3 data.

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[5] The definition of 'very hot days' and 'warm nights' is based on the 99th percentile and 90th percentile of daily maximum temperature and daily minimum temperature, respectively, over the 30-year (1991-2020) climatological period.

[6] Extreme daily rainfall is defined as the 99.9th percentile of daily rainfall over the 1995-2014 period (V3 baseline to calculate changes, in-line with IPCC AR6).

[7] A dry spell is defined as an episode of at least 15 consecutive days with island-wide rainfall of less than 1mm for each day.

12 To deepen our understanding of the impacts of climate change, NEA today also launched the second grant call under the Climate Impacts Science Research (CISR) Programme[8] for new research proposals on food security, impacts on human health, water resources, sea level rise and impacts on maritime infrastructure and the transport sector. In December last year, eight projects were awarded under the Programme's first grant call. These projects will make use of V3 results to look into areas like the impact of climate change on vector-borne diseases in Singapore, changes in our tropical forest landscape, among others.

13 Government action alone will not be sufficient. Everyone – individuals, communities, and corporates – has a role to play to promote sustainability and mitigate climate change. Members of the public seeking to learn how to fight climate change may visit: www.mse.gov.sg/policies/climate-change/climategamechanger.

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[8] Further details on the CISR Programme is available at the CISR Programme website.

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About the Ministry of Sustainability and the Environment

The Ministry of Sustainability and the Environment (MSE) is committed to providing Singaporeans with a clean and sustainable environment, and resilient supplies of safe food and water.

MSE works alongside its three statutory boards – the National Environment Agency (NEA), PUB, Singapore's National Water Agency, and the Singapore Food Agency (SFA) – to achieve this mission through innovation, technology, and vibrant partnerships with the private, public, and people (3P) sectors.

For more information, please visit http://www.mse.gov.sg/
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About the National Environment Agency

The National Environment Agency (NEA) is the leading public organisation responsible for ensuring a clean and sustainable environment for Singapore. Its key roles are to improve and sustain a clean environment, promote sustainability and resource efficiency, maintain high public health standards, provide timely and reliable meteorological information, and encourage a vibrant hawker culture. NEA works closely with its partners and the community to develop and spearhead environmental and public health initiatives and programmes. It is committed to motivating every individual to care for the environment as a way of life, in order to build a liveable and sustainable Singapore for present and future generations.

For more information, visit www.nea.gov.sg

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About the Meteorological Service Singapore (MSS)

The Meteorological Service Singapore (MSS) is the national authority on weather and climate. It provides forecast and information services to the public, government agencies and industry. Through the provision of reliable and timely services, MSS aims to contribute to the social and economic well-being of Singapore.

The Centre for Climate Research Singapore (CCRS) is a research institute under MSS. Officially launched in March 2013, CCRS supports Singapore's efforts in climate resilience by producing long-term climate projections. These are meant to provide robust input to studies on climate impacts and adaptation.

Key Findings from V3 for Three Shared Socio-economic Pathways (SSPs)

	V3 Key Findings		
Variable	**SSP1-2.6**	**SSP2-4.5**	**SSP5-8.5**
Increase in mean sea level (m)	0.23 to 0.74	0.34 to 0.88	0.54 to 1.15
Mean daily temperature (°C)	28.5 to 29.5	29.3 to 30.7	30.7 to 32.9
Mean daily WBGT (°C)	27.1 to 28.0	27.8 to 29.0	29.1 to 30.9
Mean maximum daily temperature (°C)	31.9 to 33.1	32.8 to 34.4	34.3 to 36.7
Mean maximum daily WBGT (°C)	30.8 to 31.6	31.5 to 32.5	32.6 to 34.3
No. of very hot days[9] per year	41 to 125	103 to 261	252 to 351
No. of warm nights[9] per year	312 to 361	360 to 365	365
No. of high heat stress days per year	54 to 135	107 to 205	207 to 326
Annual average rainfall (mm)	2608 to 3234	2452 to 2921	2295 to 3052
10m wind	10m wind speed to increase by up to 20%, by end-century		

[9] The definition of 'very hot days' and 'warm nights' is based on the 99th percentile and 90th percentile of daily maximum temperature and daily minimum temperature, respectively, over the 30-year (1991-2020) climatological period.

Riding the Climate Wave: How Singapore Stays Ahead in Adaptation

SG GREEN PLAN

RIDING THE CLIMATE WAVE:

HOW SINGAPORE STAYS AHEAD IN ADAPTATION

As a low-lying tropical island state, Singapore takes the impact of climate change very seriously. We have taken steps to safeguard our future. Through building a strong, resilient community, we can adapt better to a changing climate and be prepared for extreme weather events.

Flood & Coastal Resilience

- Strengthening flood resilience through catchment-wide solutions at the Source (e.g. building detention tanks), Pathway (e.g. widening and deepening drains & canals) and Receptor (e.g. implementing platform levels and crest protection)
- Studying Singapore's coastlines through progressive site-specific studies to develop solutions for sea-level rise, (e.g. 'Long Island' at East Coast)
- Developing capabilities and addressing flood risks holistically through development of Coastal-Inland Flood Model and Coastal Protection and Flood Resilience Institute (CFI) Singapore

Water Sustainability

- Planning ahead to ensure we have enough water infrastructure, including weather-resilient sources such as NEWater and desalination plants, to protect our water supply
- Driving awareness and behavioural change for greater water efficiency and conservation

Heat Resilience

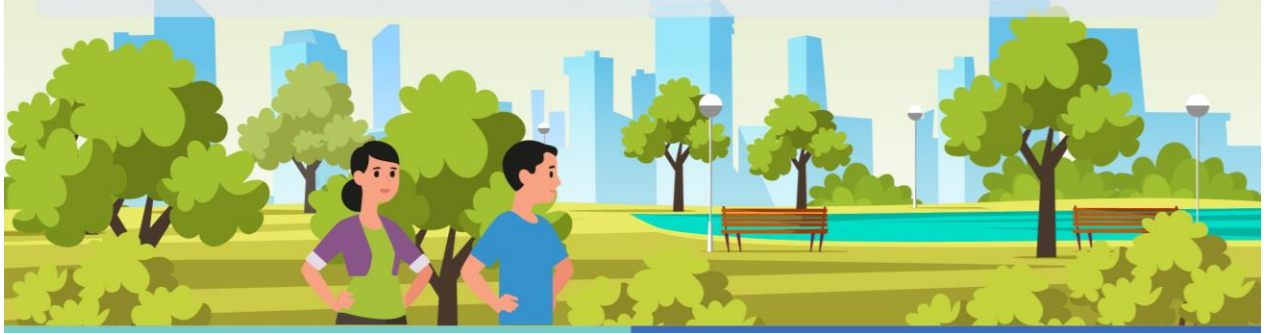
- Strengthening community heat resilience with the Heat Stress Advisory
- Cooling urban spaces by intensifying greenery and deploying cool paint to reduce heat absorption
- Using modelling to inform district and estate planning, (e.g. by preserving wind corridors)

Food Resilience

- Diversifying import sources to reduce risk of over relying on any single food supply source
- Encouraging the local agri-food industry to use technologies for productive, climate-resilient and resource-efficient production, which will help to build their capability and capacity to sustainably produce 30 percent of Singapore's nutritional needs by 2030
- Stock piling essential food items

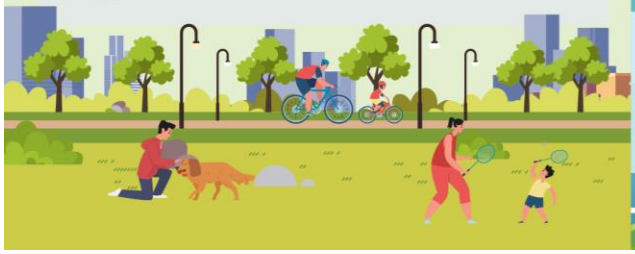
Biodiversity and Greenery

- Transforming Singapore into a City in Nature by conserving and extending Singapore's natural capital island-wide, such as by planting one million more trees across Singapore from 2020 to 2030, which helps to cool our surroundings
- Implementing habitat restoration and species recovery plans to strengthen the conservation of native plant and animal species, which helps to ensure that our ecosystems remain resilient in the face of climate change
- Leveraging technology for tree inspection and monitoring to mitigate risk of tree failure during severe weather



Public Health

- Controlling dengue transmission through innovative solutions such as *Wolbachia* technology and stronger community action
- Enhancing biosurveillance programmes through a multi-disciplinary approach involving various OneHealth agencies to study the risks and potential management strategies for diseases transmitted between animals and humans



Infrastructure Resilience

- Reviewing building codes to ensure structural integrity of infrastructure and climate-proofing our network infrastructure (e.g. transport, telecommunications and energy) to withstand projected changes such as higher temperatures and increased wind speeds