Assessment of Solar Geoengineering Impact on Precipitation and Temperature Extremes in the Muda River Basin, Malaysia using CMIP6 SSP and GeoMIP6 G6 simulations

Source: https://www.youtube.com/watch?v=dSu5sXmsur4

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TheStar As the planet heats up, Malaysia needs to look beyond rice for food security

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As the planet heats up, Malaysia needs to look beyond rice for food security

By DZOF AZMI

LIVING

Sunday, 21 Nov 2021
6:00 PM MYT

Malaysia

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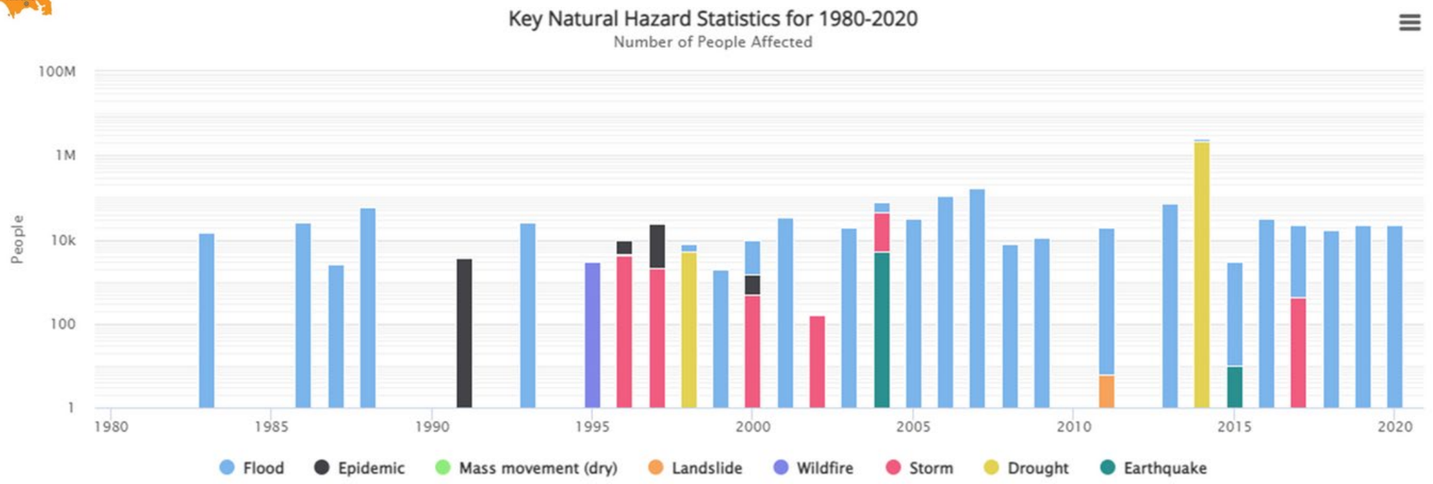
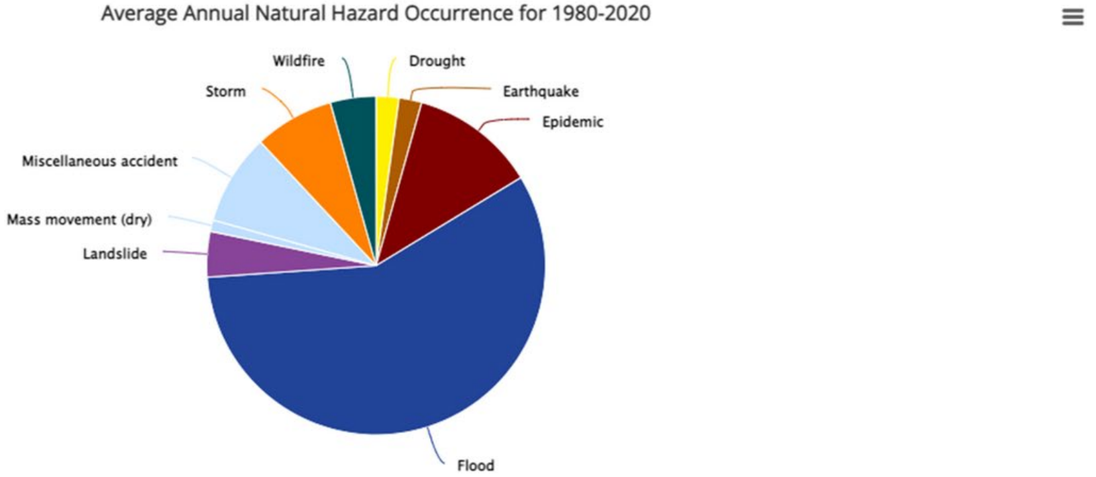
Malaysia floods caused nearly $1.5 billion in losses, government report says

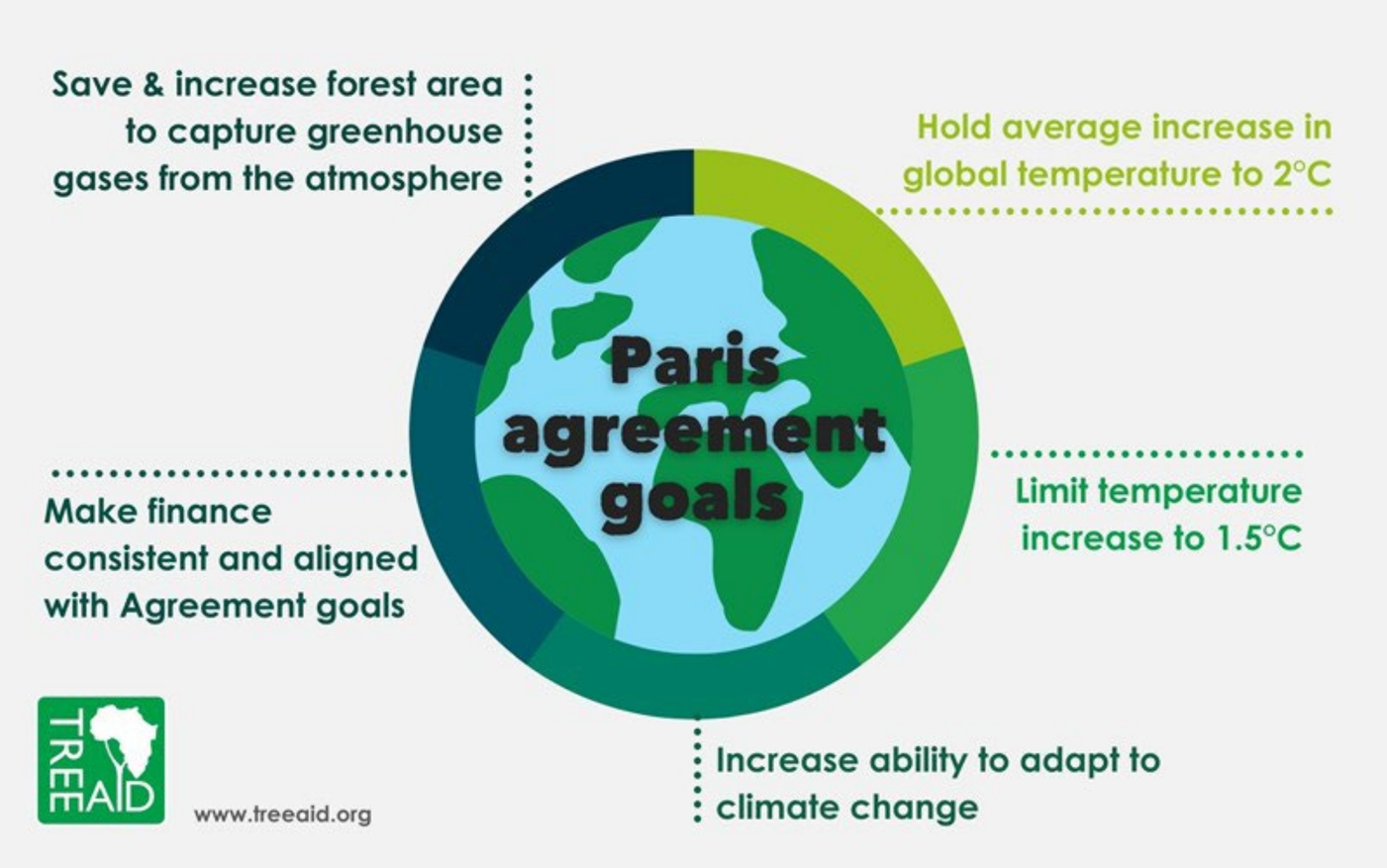
Reuters

Aerial view shows vehicles and buildings inundated by floods in Shah Alam's Taman Sri Muda, one of the worst hit neighbourhoods in Selangor state, Malaysia, December 21, 2021. Picture taken with a drone. REUTERS/Ebrahim Harris





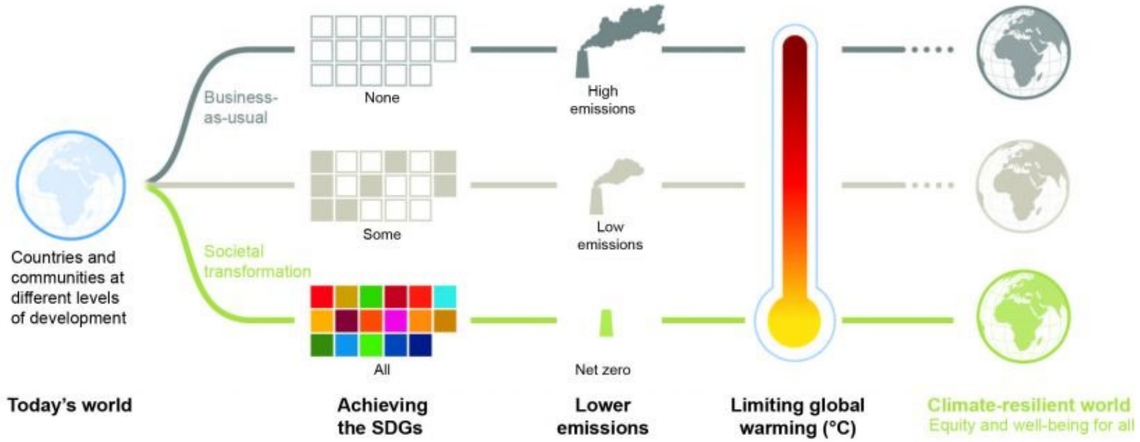
Paris Climate Agreement



" Given the current global efforts and challenges in addressing climate change, do you believe it is still possible for us to achieve the goals of the Paris Agreement by limiting global warming to well below 2°C, ideally 1.5°C? "

FAQ5.2: **Climate-resilient development pathways**

Decision-making that achieves the United Nation Sustainable Development Goals (SDGs), lowers greenhouse gas emissions, limits global warming and enables adaptation could help lead to a climate-resilient world.



Source: https://www.ipcc.ch/sr15/chapter/chapter-5/faq-5-2-2/

→ **Climate Plans Remain Insufficient: More Ambitious Action Needed Now**

26 October 2022

UN Climate Press Release

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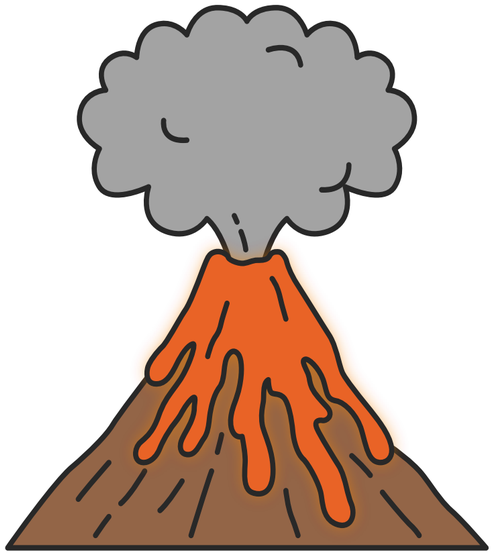
https://unfccc.int/news/climate-plans-remain-insufficient-more-ambitious-action-needed-now

Target

vs

Reality



The 1991 volcanic eruption of Mt. Pinatubo produced the largest sulfur dioxide (SO_2) eruption cloud ever measured – at least 18 million tonne.

Solar Geoengineering?

"Global mean air temperatures were reduced, by up to 0·5°C at the surface and 0·6°C in the troposphere, for some months in mid-1992, in approximate accord with model predictions"

Parker, D.E., Wilson, H., Jones, P.D., Christy, J.R., Folland, C.K., 1996. The impact of Mount Pinatubo on worldwide temperatures. International Journal of Climatology 16, 487–497.

"A cooling of up to 0.5°C which lasted 1–3 years months is attributed to the 1991 Mt. Pinatubo eruption… The cooling is estimated at up to 0.28°C, 0.2°C on average. Similarly shorter is the duration of the cooling, about 18 months."

Boretti, A., 2024. Reassessing the cooling that followed the 1991 volcanic eruption of Mt. Pinatubo. Journal of Atmospheric and Solar-Terrestrial Physics 256, 106187.

Following the eruption of Mount Pinatubo in June 1991 there was a substantial decrease in precipitation over land and a record decrease in runoff and river discharge into the ocean from October 1991–September 1992.

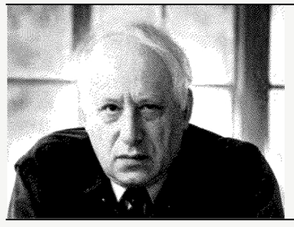
Trenberth, K.E., Dai, A., 2007. Effects of Mount Pinatubo volcanic eruption on the hydrological cycle as an analog of geoengineering. Geophysical Research Letters 34

REFLECTING THE SUN TO COOL THE EARTH

1965

US President Lyndon B. Johnson's Science Advisory Committee publishes "Restoring the Quality of Our Environment." It suggests that raising the albedo, or reflectivity, of the Earth could help combat unwanted changes to the climate caused by increased greenhouse gasses in the atmosphere.

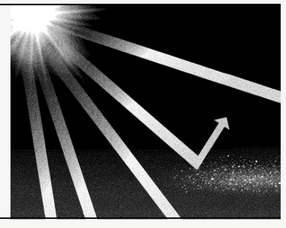
1974



Soviet climatologist Mikhail Budyko suggests that the threat of global warming could be countered by using airplanes to inject sulfate aerosols into the stratosphere. This idea — stratospheric aerosol injection (SAI) — is also known as "Budyko's Blanket."

1977

The US National Academies of Sciences addresses the idea of making the Earth more reflective to combat climate change for the first time, but notes that "no practical, plausible, and reliable means to accomplish such an increase seem to be at hand."



1991

Mount Pinatubo erupts in the Philippines, releasing at least 18 million tons of sulfur dioxide into the atmosphere. This causes global temperatures to drop by about 0.5 C (0.9 F) over the following year, providing new evidence that SAI could temporarily lower global temperatures.

2006

Nobel Prize winner Paul Crutzen publishes a scientific essay digging into the potential of SAI to combat global warming. The essay helps break a taboo around the study of solar geoengineering.

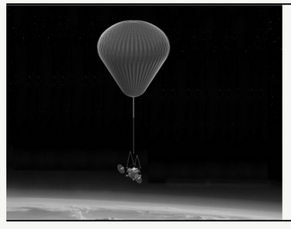
2006

NASA co-sponsors the "Solar Radiation Management (SRM)" workshop to identify what policymakers might need to know to make informed decisions about using SAI and similar techniques to combat climate change.

2009

The "Stratospheric Particle Injection for Climate Engineering" (SPICE) project launches, led by Bristol University. Plans to conduct field tests of SAI are called off in 2012, in part because the team is concerned about a "lack of clear and specific guidelines for geoengineering research."

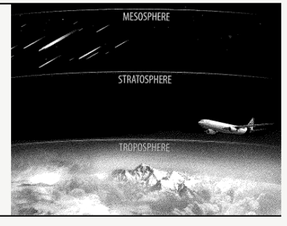
2019



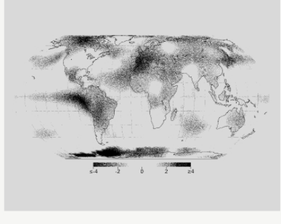
Harvard researchers try to launch an experiment to study how particles of the reflective material calcium carbonate act in the stratosphere. The project, called the Stratospheric Controlled Perturbation Experiment (SCoPEx), generates backlash and is officially abandoned in 2024 before any field tests are done.

2022

UK researcher Andrew Lockley reportedly sends a balloon containing sulfur dioxide to the stratosphere where it bursts. MIT Technology Review, which breaks the story in 2023, says the experiment may be the first intentional deployment of a gas into the stratosphere "as part of a geoengineering-related effort." No paper on the experiment has yet been published.



2023



The White House Office of Science and Technology Policy releases a five-year research plan for studying SAI and other forms of SRM. Though it doesn't commit to launching a program, the creation of the plan is seen by many as a sign that the US is now seriously considering solar geoengineering.

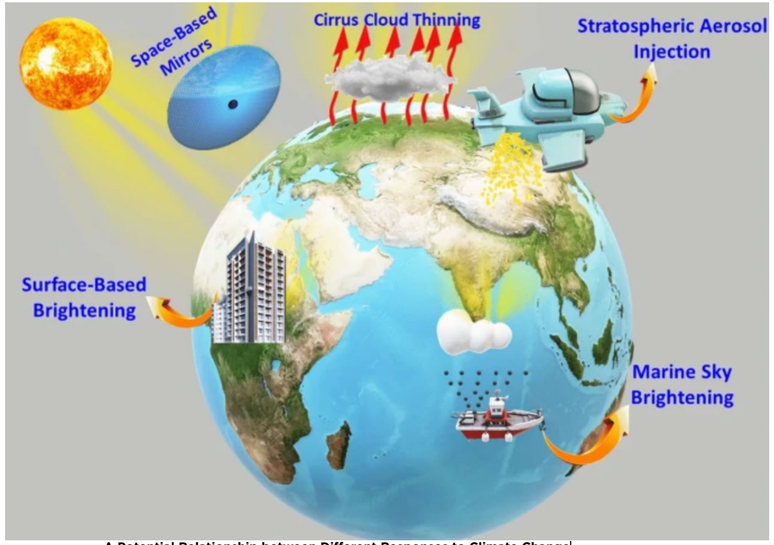
Freethink / FUTUREXPLORED

Source: https://www.freethink.com/energy/sai-make-sunsets

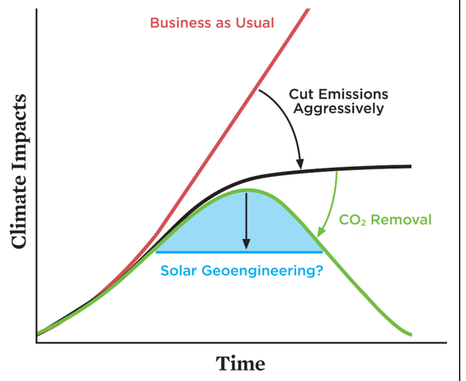
Geoengineering

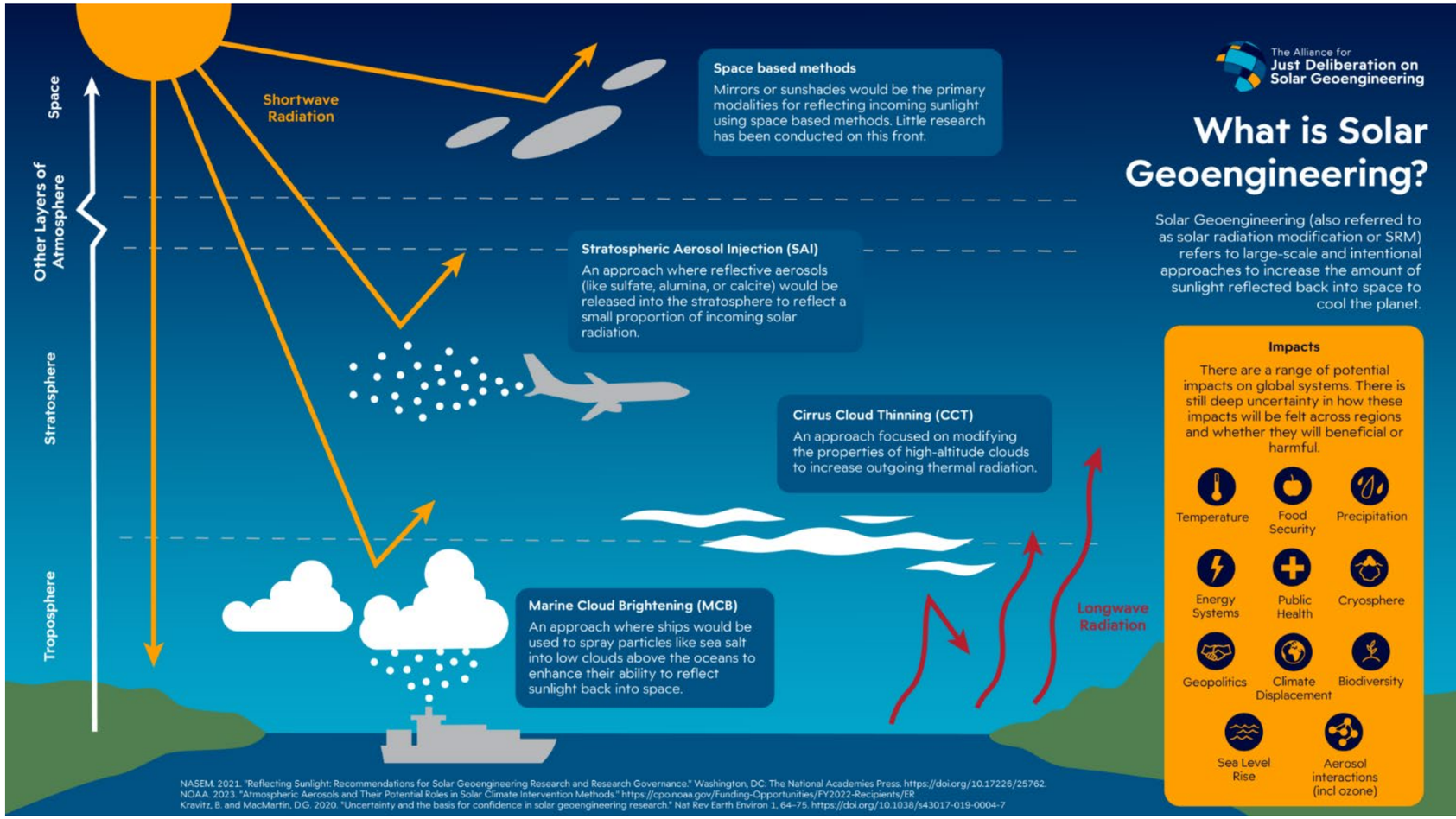
Carbon Geoengineering (Carbon Dioxide Removal)

Solar Geoengineering (Solar Radiation Modification)



A Potential Relationship between Different Responses to Climate Change





Fawzy S., Osman, A.I., Doran, J. *et al.* Strategies for mitigation of climate change: a review. *Environ Chem Lett* 18, 2069–2094 (2020). https://doi.org/10.1007/s10311-020-01059-w

https://kleinmanenergy.upenn.edu/research/publications/a-new-era-of-policy-in-solar-geoengineering/

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Assessment of solar geoengineering impact on precipitation and temperature extremes in the Muda River Basin, Malaysia using CMIP6 SSP and GeoMIP6 G6 simulations

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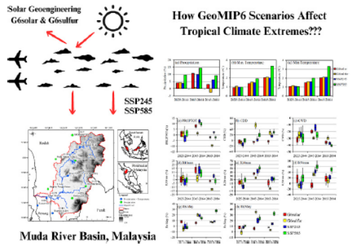
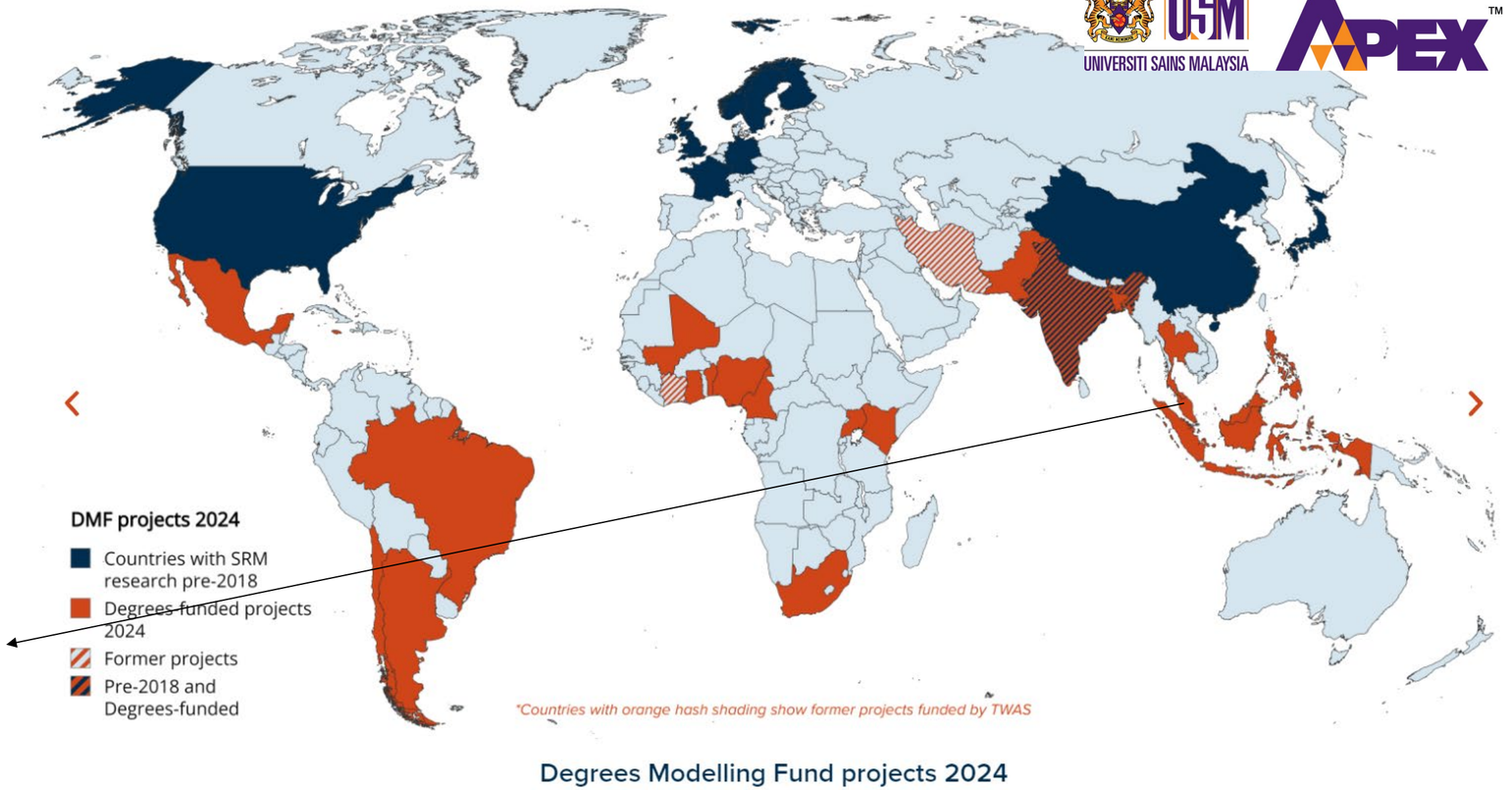
HIGHLIGHTS

- G6sulfur may exacerbate dry spells of the Muda River basin (MRB) in the future.
- G6solar and G6sulfur modulate the MRB's climate increases of SSP585 to match SSP245.
- G6solar, G6sulfur and SSP245 project ~2 °C temperature increase in the MRB.
- G6solar and G6sulfur modulate increases precipitation extremes to match SSP245.
- Future studies should consider more SRM experiments and hydro-climatic modelling.

GRAPHICAL ABSTRACT



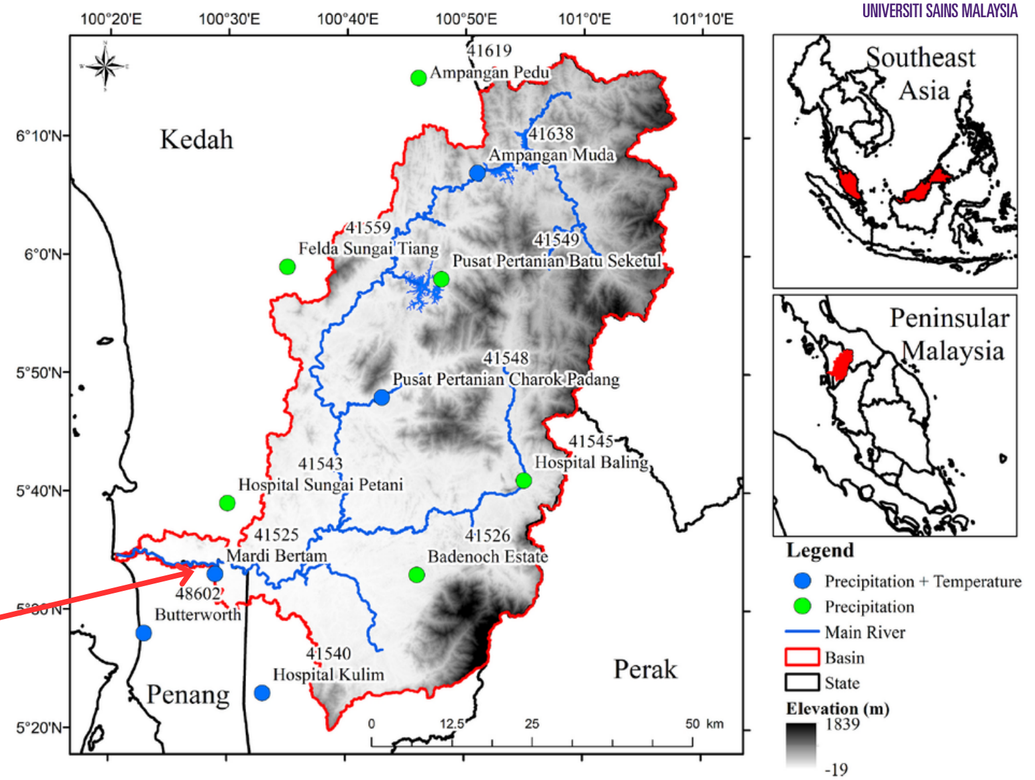


Degrees-funded scientists, research collaborators, friends and staff at the 2024 GeoMIP meeting in Ithaca, New York. Photo Credit: The Degrees Initiative.

Degrees holds workshop on regionalising SRM research in Southeast Asia

Degrees-funded scientists from across Southeast Asia came together in Singapore on 16 – 17 January 2024 to showcase their work and discuss ideas for a regional collaboration network on SRM research.

The primary aim of the research is to compare the impacts of solar geoengineering, as simulated in the G6solar and G6sulfur experiments and the commonly used CMIP6 SSP experiments, on precipitation and temperature extremesin the Muda River Basin.

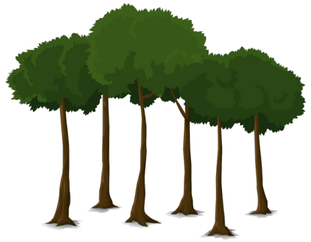


Raw Water Risk

Penang

Only one key raw water resource

- 80% from Muda River.



Upstream developments of Muda River Basin

- logging
- rare earth mining.

Sungai Perak Raw Water Transfer Scheme (SPRWTS)

- Second potential water source, but the discussion has been delayed.

Climate Change

- Affectedrainfall in the water catchment areas of dams

Future water demand

- 845 MLD in 2020 to 1,884 MLD by 2050.

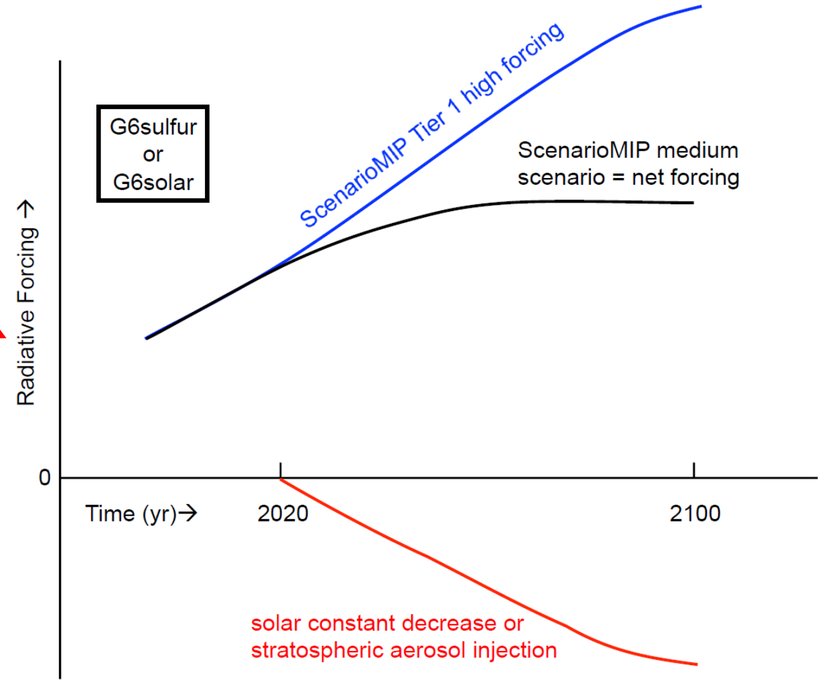
High per capita domestic consumption

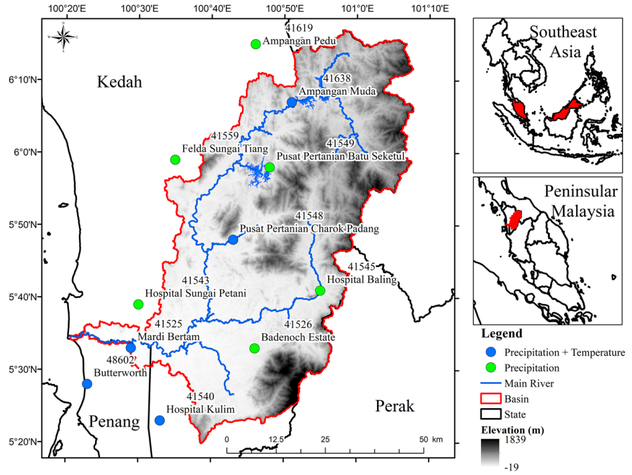
- In 2020, it reached 299 litres/capita/day (LCD).
- WHO--> 165 LCD

https://pba.com.my/raw-water-risks/

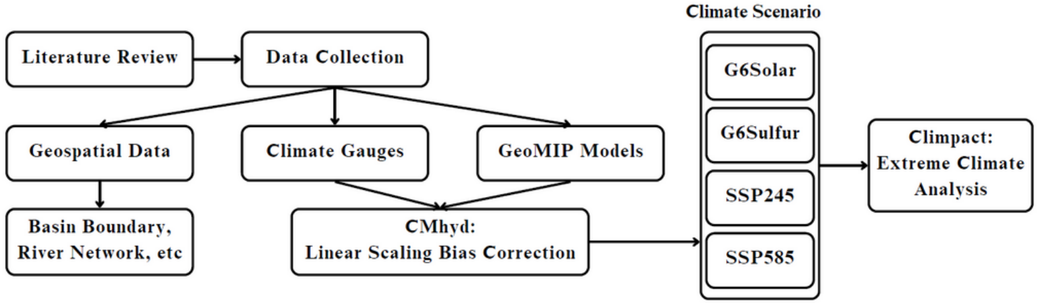
Tier 1 GeoMIP experiments

	Solar Dimming	Sulfate	Surface Albedo	Cloud brightening	
Constant Forcing	G1	G4	G1 ocean-albedo	G4cndc G4sea-salt	-Models' response to a step function input -Easier to set up and define across models
Time-varying Forcing	G2 G3S G6solar	G3 G6sulfur		G3-SSCE	-Varying level of intervention allows for exploration of emerging signal -Better-defined temporal baseline against which to compare -More "realistic" deployment scenario -May depend on models' sensitivity
	-Easy to replicate across models' complexities and models' versions -Comparison with more complex global methods	-Models' spread in latitudinal distribution of aerosols -Contribution of aerosol perturbation to surface climate and stratosphere	-Idealized representation of spatially heterogeneous methods -Comparison with more complex regional methods	-Good first step in simulating other, more regional, methods -Models used might not be simulating all relevant processes happening at a lower spatial scale -Unrealistic assumptions over size of aerosols injected	





Distribution of climate stations within and surrounding the Muda River Basin, Malaysia.

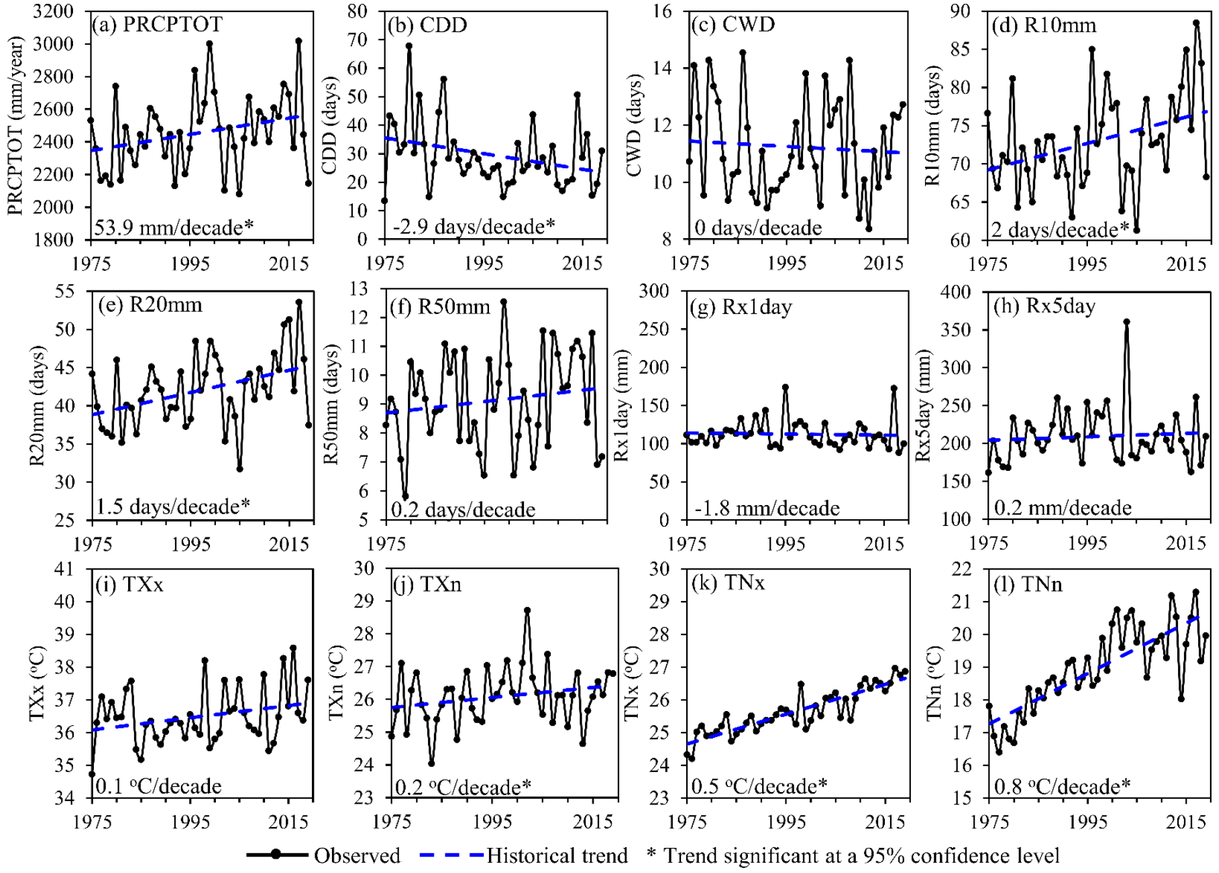


Research Methodology Flow

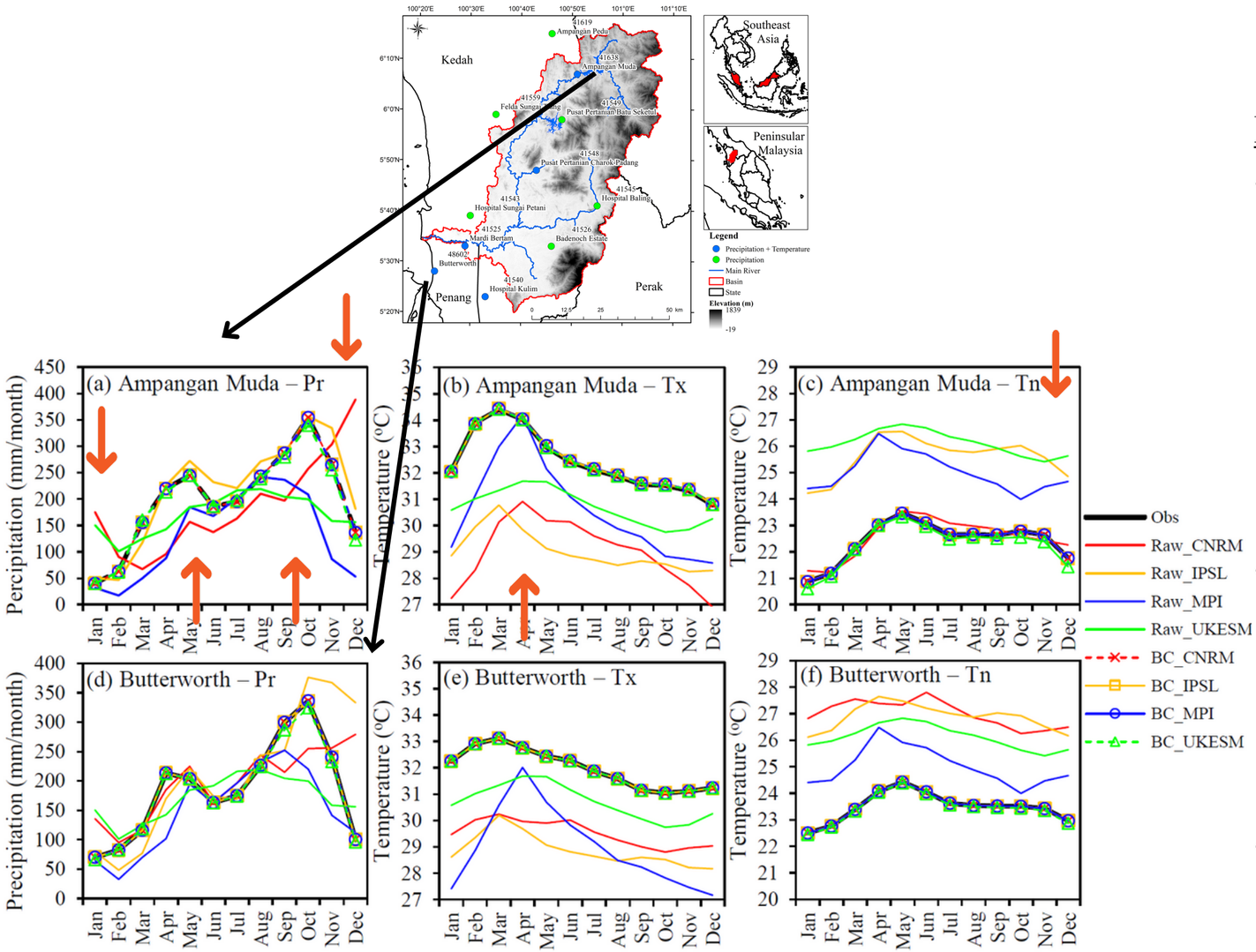
GeoMIP models selected for this study

Reference	Name	Institution	Variant	Resolution
Séférian et al. (2019)	CNRM-ESM2-1	Centre National de Recherches Météorologiques (CNRM)	r1i1p1f2	H: 256 x 128; V: 40
Boucher et al. (2020)	IPSL-CM6A-LR	Institut Pierre-Simon Laplace (IPSL)	r1i1p1f1	H: 144 x143; V: 79
Müller et al. (2018)	MPI-ESM1-2-LR	Max Planck Institute (MPI) for Meteorology	r1i1p1f1	H: 192 x 96; V: 47
Sellar et al. (2019)	UKESM1-0-LL	Met Office Hadley Centre	r1i1p1f2	H: 144 x 192; V: 85

* H represents horizontal resolution as longitude points x latitude points, and V represents vertical layers.



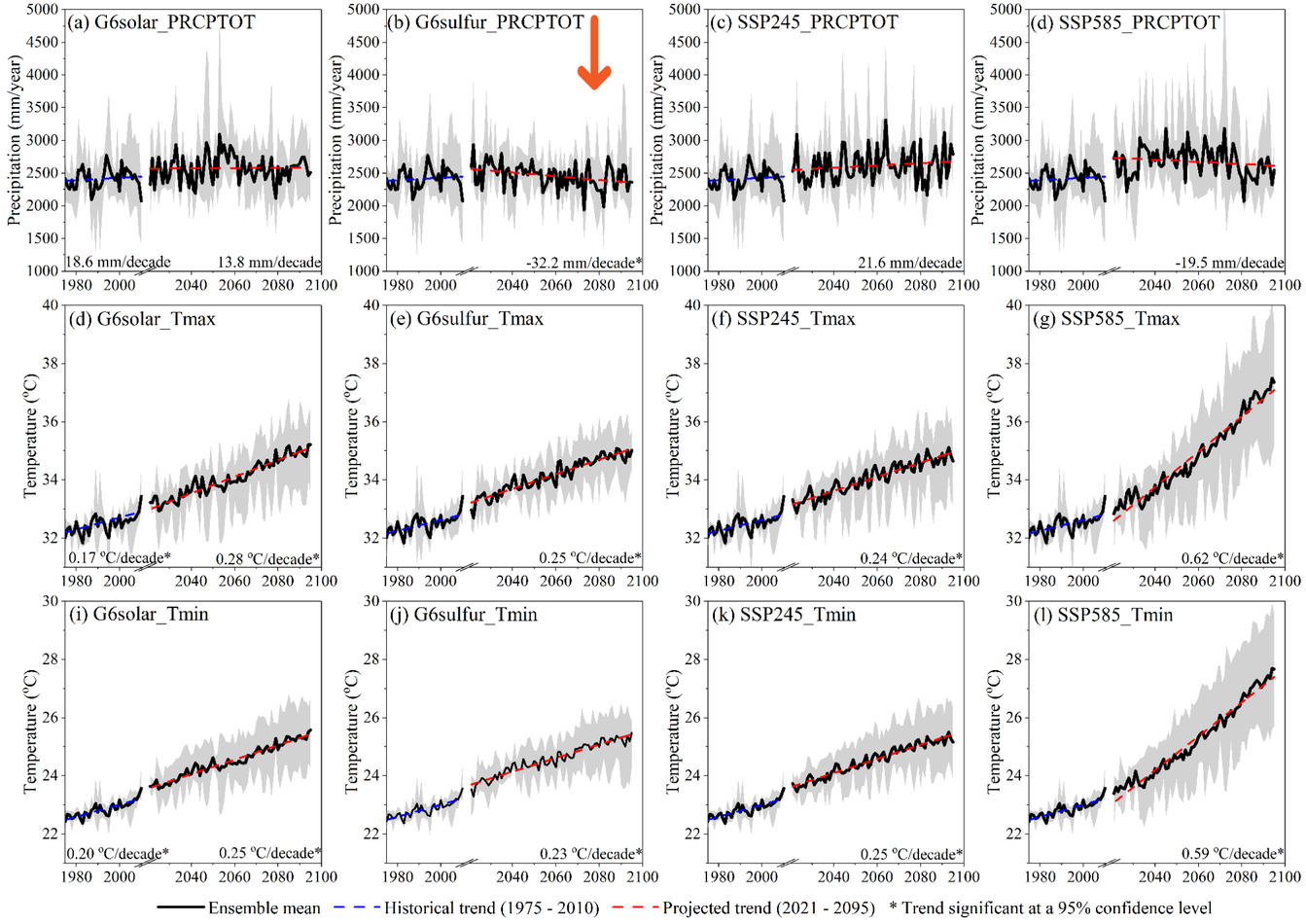
The Changes of Historical Precipitation and Temperature Extremes over the Muda River Basin from 1975 to 2015.



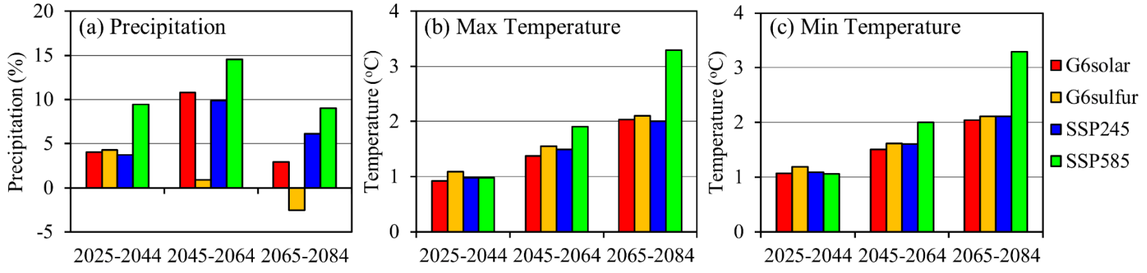
The climatological comparison between the observations of the Ampangan Muda (upper basin) and Butterworth (lower basin), the raw and bias corrected (BC) GeoMIP models from 1975 to 2014 .

Bias Correction of GeoMIP models

- It is noted that large wet biases were found in the CNRM-ESM2-1 and IPSL-CM6A-LR models during the early Northeast Monsoon season (November - January). While, the GeoMIP models tended to underestimate the peak monthly precipitation during the inter-monsoon periods (April and October), except for the IPSL-CM6A-LR model
- Throughout the year, there were noticeable biases in the surface temperature of the GeoMIP models. In particular, they included warm biases from overestimating the minimum temperature and cold biases from underestimating the maximum temperature.
- The warm and cold biases in the surface temperature simulations, as well as the wet biases of precipitation during the early northeast monsoon and the dry biases during the inter-monsoon period, were all largely corrected by the bias correction.



Temporal trends of annual total precipitation (PRCPTOT), annual mean maximum temperature (Tmax) and annual mean minimum temperature (Tmax) in the Muda River Basin for the periods 1975-2010 and 2021-2095. The grey shaded area represents the uncertainty range of different climate models.



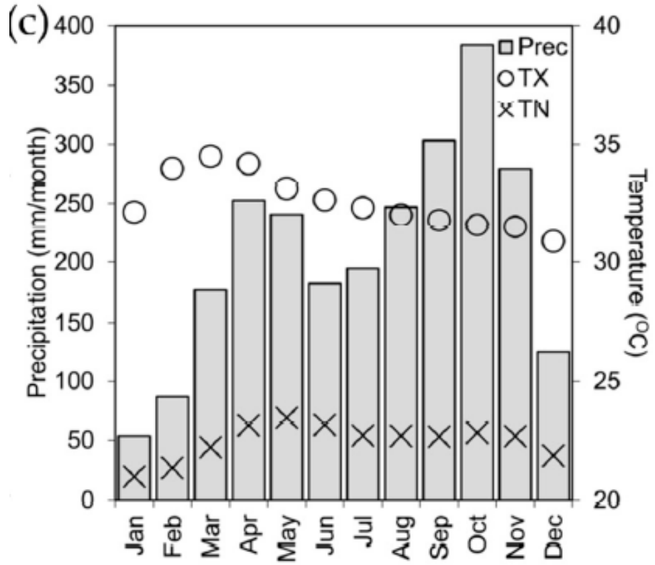
ClimaticChange

- Future PRCPTOT G6solar and SSP245 would experience steadily increasing trends by 13.8 and 21.6 mm/decade, respectively (Figures 4a and 4b), which is consistent with the historical period.
- Under SSP585, annual precipitation is projected to peak in the middle of 21st century before declining towards the end of the century.
- In contrast, the trend of annual precipitation under G6sulfur is projected to decrease significantly by 32.2 mm/decade at a 95% confidence level, indicating drier conditions might occur in the future.

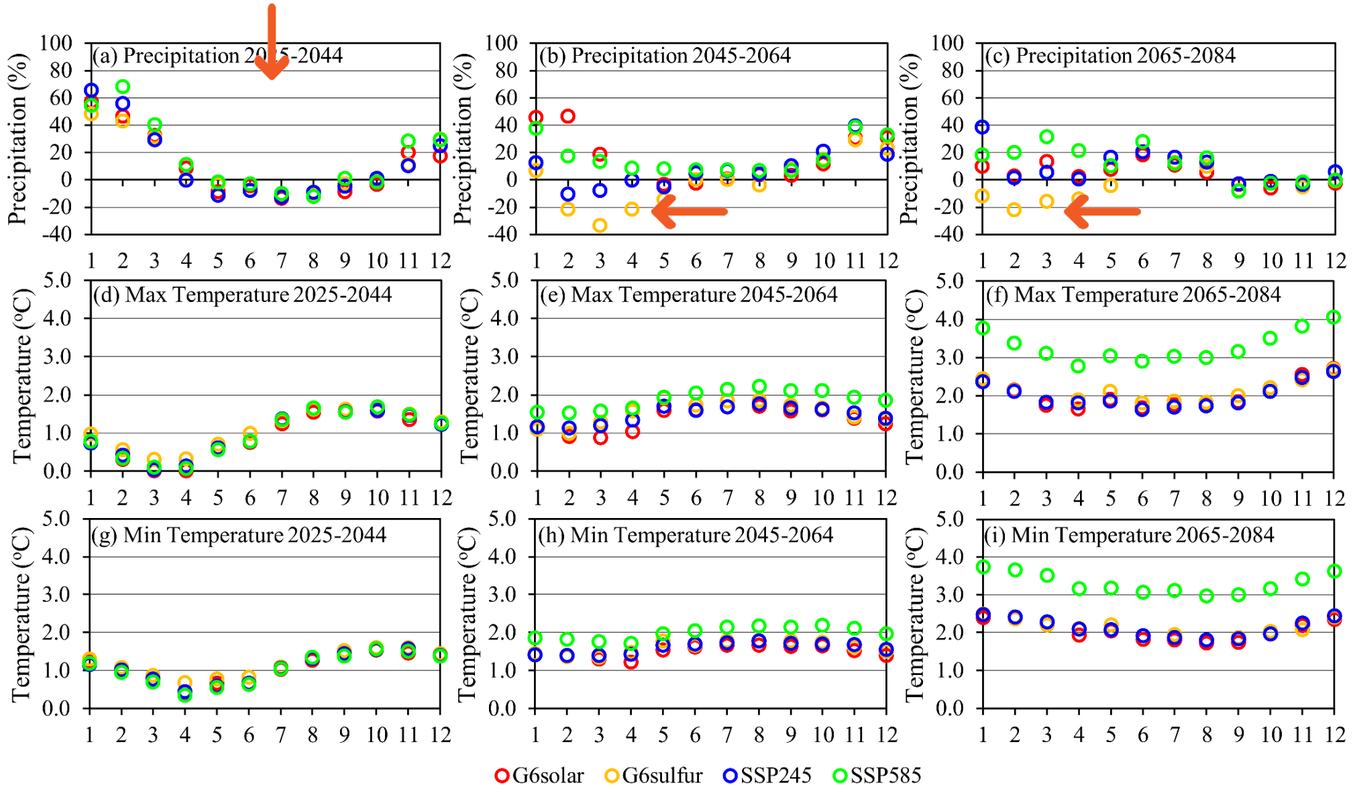
Climatic Change

- In the 2025-2044 period, monthly precipitation is projected to increase during the northeast monsoon from November to March and decrease during the southwest monsoon from May to September.

- Figure 6(b) shows that G6sulfur may exacerbate this situation, leading to a decrease in monthly precipitation by up to 33.5% and 21.5% during the periods of 2045-2064 and 2065-2084, respectively.

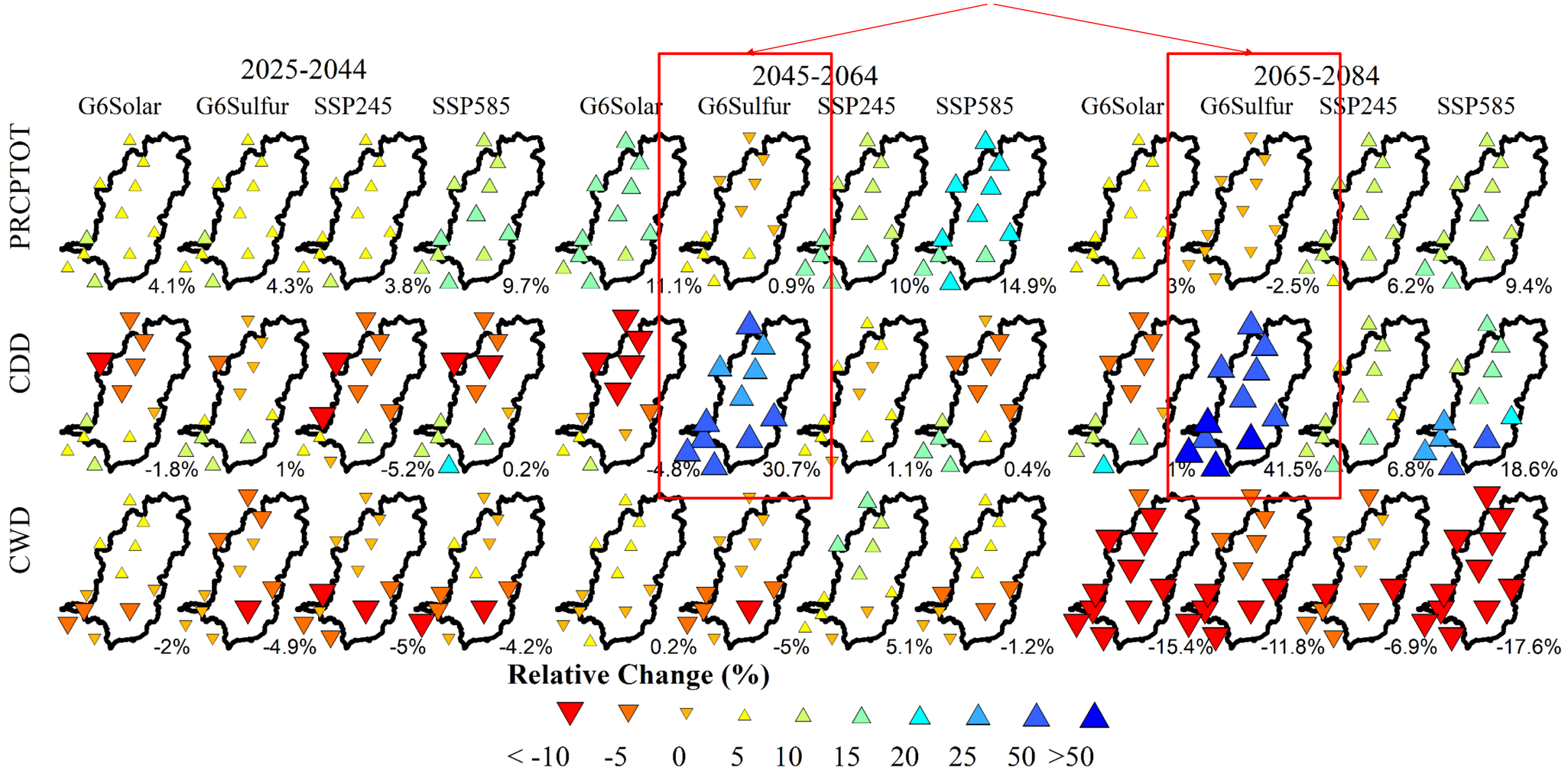


Historical monthly precipitation and temperature changes

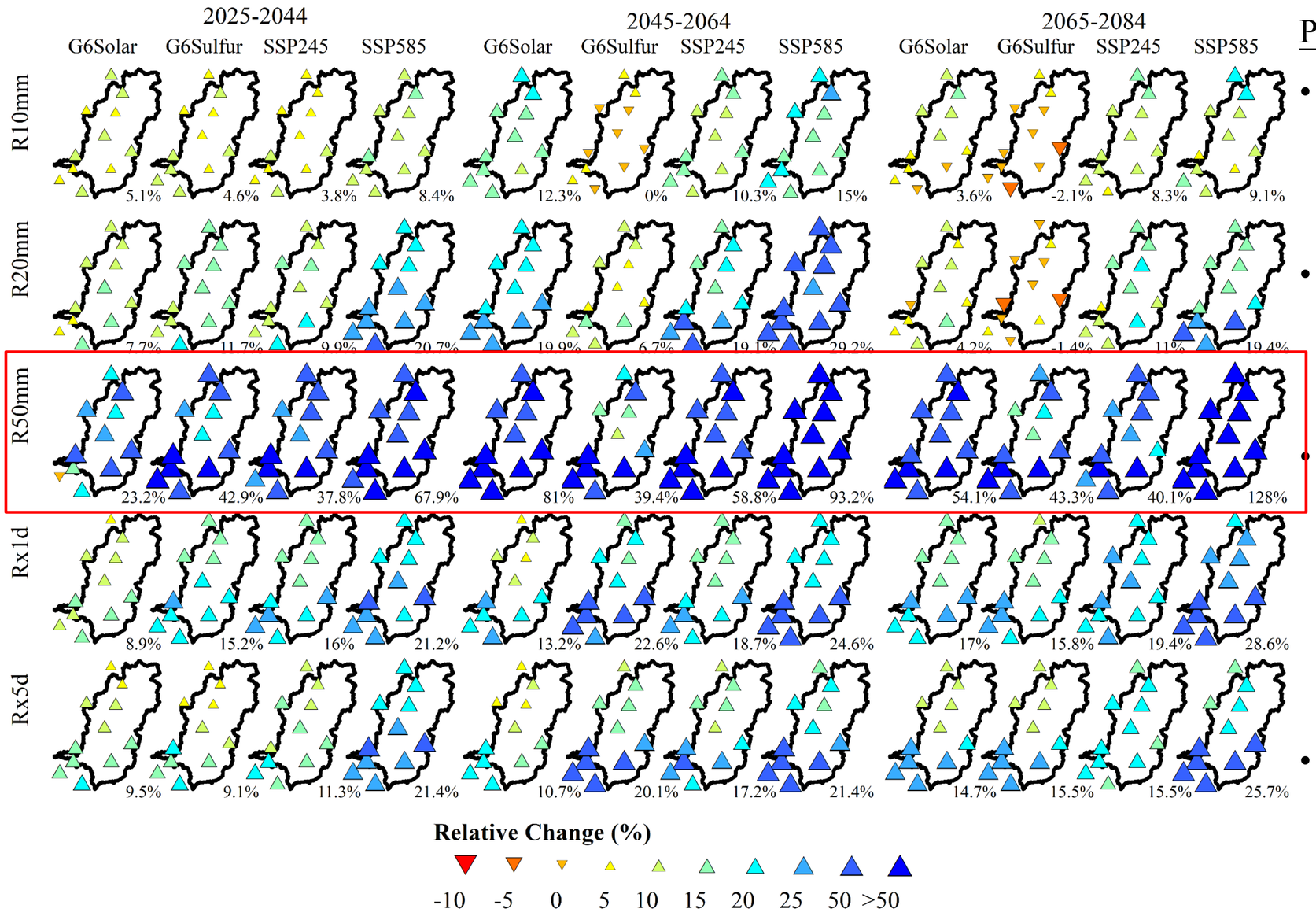


Future changes in multi-model ensemble mean monthly precipitation, maximum and minimum temperature based the multi-model ensemble mean over the Muda River Basin under the G6solar, G6sulfur, SSP245 and SSP585 experiments for the 2025–2044, 2045–2064 and 2065–2084 periods against the 1985–2004 baseline period.

Sulfate aerosols help in cooling the Earth's surface by reflecting incoming solar radiation. However, the cooler condition may also **change atmospheric circulation patterns and decrease evaporation**. Lower evaporation rates result in lower atmospheric moisture levels, leading to reduced precipitation and ultimately drier conditions in the MRB.



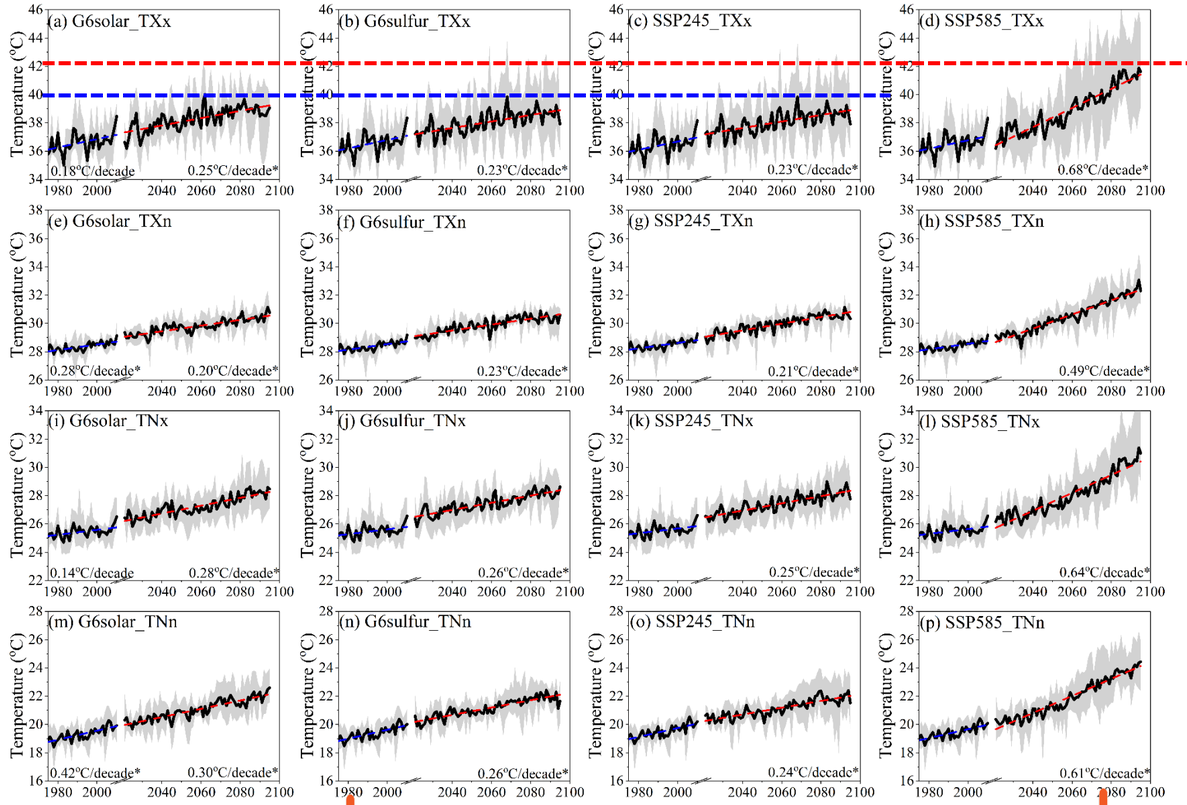
Precipitation Extremes: Relative changes of projected total precipitation (PRCPTOT), consecutive dry days (CDD) and consecutive wet days (CWD) based on multi-model ensemble mean over the Muda River basin under the G6solar, G6sulfur, SSP245 and SSP585 experiments for the 2025–2044, 2045–2064 and 2065–2084 periods against the 1985–2004 baseline period.

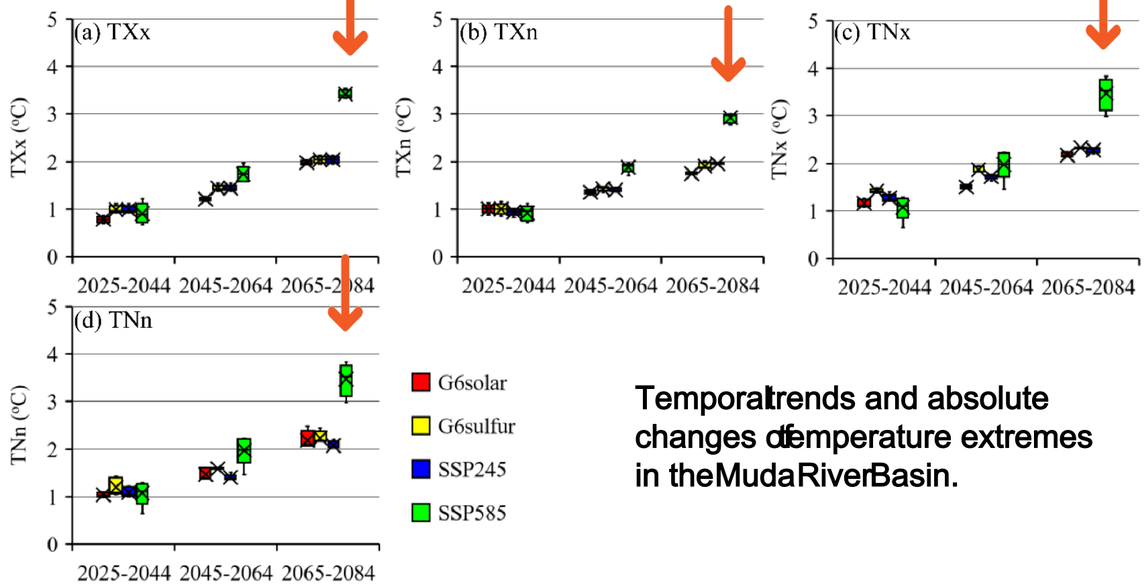


Relative changes of projected annual count of days when daily precipitation ≥ 10 mm (R10mm), > 20 mm (R20mm), > 50 mm (R50mm), annual maximum 1-day (Rx1d) and 5-day (Rx5d) based on multi-model ensemble mean over the Muda River basin under the G6solar, G6sulfur, SSP245 and SSP485 experiments for the 2025–2044, 2045–2064 and 2065–2084 periods against the 1985–2004 baseline period.

Precipitation Extremes

- Most of the flood-related precipitation extremes over the MRB are projected to increase in the future.
- Interestingly, G6Solar matching the increased frequency projected by SSP245 and G6sulfur showing decreased frequency.
- Rising levels of aerosol sulfate in the atmosphere lead to more cloud cover, particularly in tropical marine regions (Chen et al., 2024), as more cloud condensation nuclei are available for water vapour condensation.
- On the other hand, the radiative effects of aerosols reduce the amount of solar radiation reaching the land surface, causing in less heat for evaporating water and forming convective clouds (Ramanathan et al., 2001).





Temporal trends and absolute changes of temperature extremes in the Muda River Basin.

±2 ~ 2.5°C

Temperature Extremes

- The annual maximum daily maximum temperature (TXx) or hottest day, is projected to increase by 3.3 to 3.5°C during the 2065–2084 period under SSP585.
- Consistent other results, the G6solar and G6sulfur experiments project smaller increases in TXx during the 2065–2084 period from 1.9 to 2 °C and 2.0 to 2.1 °C, respectively
- These substantial decreases align with the projections under the SSP245 scenario, which shows increases of TXx by 2.0 to 2.1 °C, for the same period.

Water Watch Penang (WWP) is a non-profit organisation founded on November 1997 as part of the Sustainable Penang Initiative under the auspices of the Socio-Economic & Environmental Research Institute (SERI) of Penang.

The vision of WWP is
"To Create a Water Saving Society in Malaysia"

Our mission
"To educate and transform the public into water savvy and climate resilient society";
Our mission and vision are based on 6 Sustainable Development Goals:

Government Agencies

Non-Governmental Organisation

Government Foundation

Private Corporation/Social Enterprise

Education Institute

In 2023,
we have conducted
a total of

58 EDUCATION ACTIVITIES/ EVENTS/SESSION

and we have
educated a total of

9794 STUDENTS & 591 TEACHERS

as well as

20416 INDIVIDUALS APART FROM STUDENTS AND TEACHERS

In the year 2022, nearly

100 MILLION LITRES

of water were saved in schools
through the installation of
water-saving equipment

NEGALITRES FOR SCHOOLS

YEAR 2021-2023

TO DATE:

- A total of 105 schools registered for the programme,
- Completed the installation in 96 schools with a total of 1988 self closing tap, 174 brass nozzles and 2157 pieces of PBAPP Water saving equipment

World Water Day - Penang State Level Celebration

COLORING & PAINTING COMPETITION

PENANG STATE-LEVEL WORLD WATER DAY CELEBRATION 2024

Save Water PENANG 2030

WORLD WATER DAY 2024
PENANG, MALAYSIA

THEME: 'SAVE WATER FOR PENANG2030'

FREE ONLINE REGISTRATION
LIMITED SLOTS AVAILABLE!

FREE REGISTRATION

OPEN TO ALL MALAYSIAN WITH VALID MYKID/MYKAD

Note: Activity approved by Jabatan Pendidikan Negeri Pulau Pinang

ENGLISH

LINK: https://shorturl.at/hyQV3

BAHASA MELAYU

PAUTAN: https://shorturl.at/rBRW7

25 MAY 2024 (SATURDAY)
8AM-9AM (REGISTRATION) | 9AM-10:30 AM (COMPETITION)
VENUE: BUKIT DUMBAR PARK

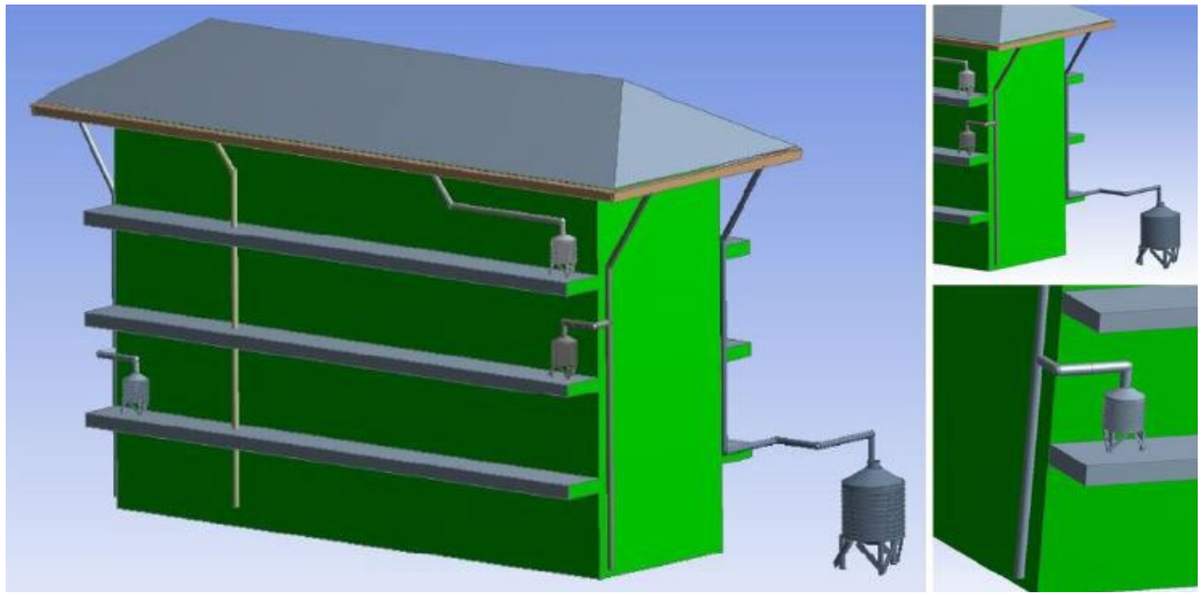
TOP THREE PRIZES (BICYCLE) FOR EACH CATEGORY TO BE WON !

A	B	C	D	E
5 - 6 years old	7 - 9 years old	10 - 12 years old	13 - 15 years old	16 - 19 years old
Coloring competition	Painting competition	Painting competition	Painting competition	Painting competition

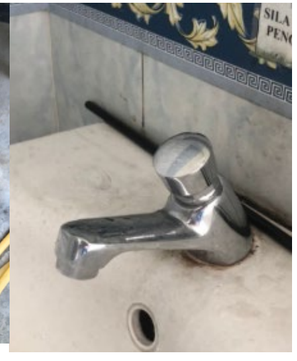
Coloring template (A3 size) and art paper (A3 size) stamped with Water Watch Penang will be provided

Installation of the rainwater harvesting system

Adrone Image of the school



Design of the rainwater harvesting system



Laman Web Rasmi | Official Website

search...

(https://news.usm.my)

Berita Mutakhir

29 APR

BJIM USM BERSAMA WATER WATCH PENANG LANCARKAN PROJEK PENUAIAN AIR HUJAN

PULAU PINANG, 29 April 2022 – **Bahagian Jaringan Industri dan Masyarakat, Universiti Sains Malaysia (BJIM-USM) dengan kerjasama Persatuan Pengamatan Air Pulau Pinang (Water Watch Penang-WWP)** baru-baru ini telah melancarkan projek penuaian air hujan (rainwater harvesting) di sekolah SJK (T) Bayan Lepas, dengan tujuan untuk memberi kesedaran kepada guru, murid-murid serta masyarakat mengenai kepentingan usaha penjimatan air di Pulau Pinang.

varnam MALAYSIA

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HOME > COMMUNITY

SJK (T) Bayan Lepas, The First In The State To Initiate A Rainwater Harvesting Project

BY NANTHINI SURESH / MAY 9, 2022

Image credit: The star

23・4・2022（星期六） A12

向學生倡導節約精神
淡小集雨省水省開支

（槟城22日讯）吉六拜淡尔小学成为全槟首所拥有水收集系统的学校，不仅得省水效果，还为学校省1个月约133令吉20仙的水。

这项计划是在槟城理科大人文学院地理系、槟城水监督组织与该校配合下推，以帮助学校节省水源及高学生及家长对节省用水醒觉。

理大人文学院地理系讲师槟城水源监督组织副主席茂龙今日在推介礼上坦，虽然我国是其中一个雨最多的国家，然而仍面对源危机，尤其是在旱季，许多地方都面对水源不足的问题。

■陈艺荣（左起）及陈茂龙向校方及学生讲解如何收集雨水后再使用。

开槟学校先河

“我们在校园内安装了1个大水箱和3个小水箱，雨水将从屋顶流向水箱，其中2个水箱的雨水将供厕所使用，另两个则用于浇花及洗地，一旦水箱没水，马桶将自动改以普通水冲洗。”

他称，上述系统耗资约2万令吉，大部分经费由理大支付，并在上个月完工，至今已使用1个月。

他指出，根据水费计算，透过上述系统，每个月能为该校省下约133令吉20仙，1年能省下约1598令吉42仙。

他希望该校能成为其他学校的榜样，也希望接下来有更多学校采用雨水收集系统。

陈茂龙也提及槟州气温上升问题，他说，根据早前向气象局取得从1985年至今槟城的气温报告，槟城的气温每10年会上升0.25至0.52摄氏度。

理大人文学院地理系教授兼槟城水源监督组织主席陈艺荣博士则说，该校也是全槟100所学校中，其中一所参加“学校节约用水计划”的学校，因此除了透过上述系统节省水源，也在校园内安装了节水设备。

“比如将厕所的冲水设备从原本每次可冲洗9公升水，改为3公升水，以及将扭开式水龙头改成按压式水龙头等，这些方式都能起到节水效果。”

他希望透过这些节水方式，能为学校省下一笔费用之余，也让小学生从小培养节省用水的习惯。(TKY)

佳日星：留住人才

展提供很多实习及就业机会。

“不少外州家长会担心槟城

River and Water Education Awareness Programme (field-based session)

TikTok Competition 2023: Together Saving Our Water

TikTok Competition 2023: Together Saving Our Water

Dates/ Duration	Total students	Total teachers	Total individuals	Other Partners
25th July to 31st October 2023	36 submissions	-	-	GeoInformatic Unit, and Geography Club, Universiti Sains Malaysia

CHAMPION: ARIFF MUHAIMIN BIN SHAFFE

FIRST RUNNER UP: HANNAH PRAISE A/P VICTOR

SECOND RUNNER UP: EUNICE JOHNEY

CONSOLATION PRIZES"

MUHAMMAD IRFAN DANIEL BIN HAMDAN

THARSHINI A/P MURTHY

TEAM 4 PEARLS

KWONG WENG ER

NG CHI VERN

SITI NURAISHA SAFIYYAH BINTI SAMSURIE

KWONG WENG SHEN

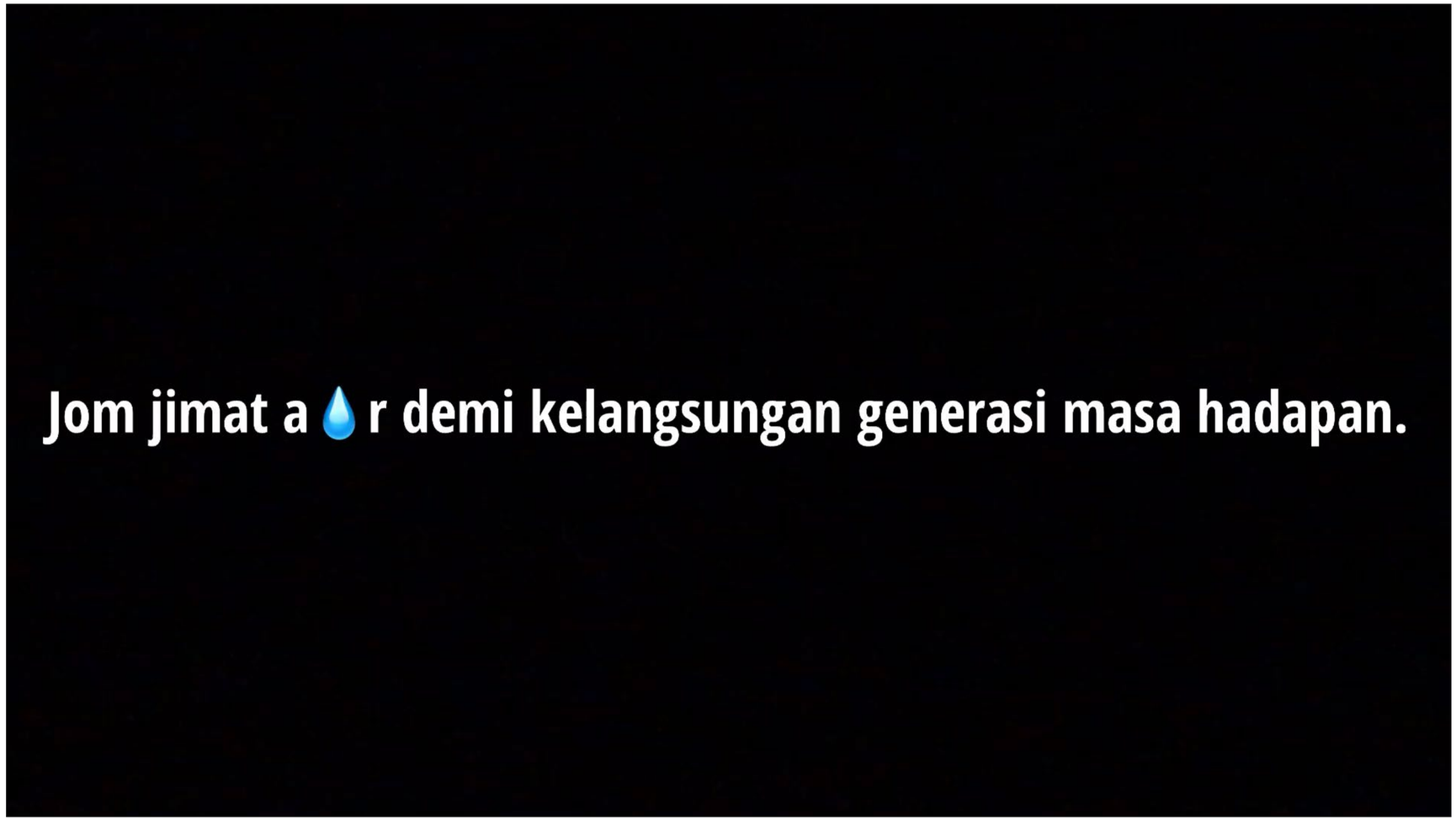
THE THREE MUSKETEERS

MUHAMMAD IRSYHAD BIN MOHD SHUKRI

ZEROSE

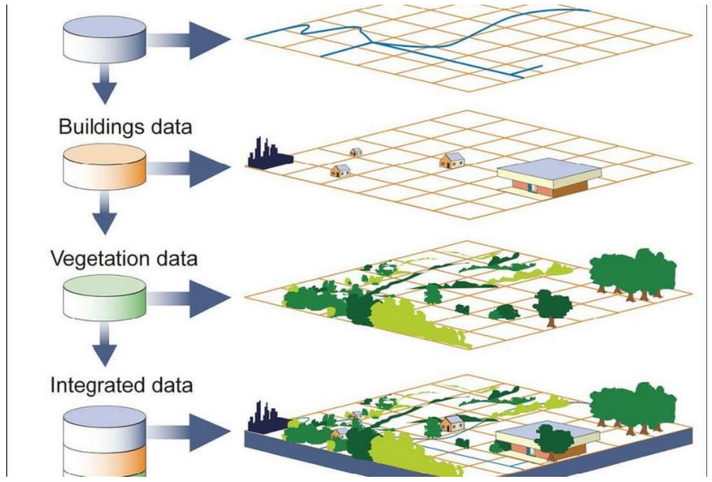
Followour Facebook page

TikTokWater Saving Competition 2023



Drone River Care Programme

Total activities/ Events/ Sessions	Dates/ Duration	Total students	Total teachers	Total individuals	Other Partners
1	15th Dec 2023	40	-	-	GeoInformatic Unit, and Geography Club, Universiti Sains Malaysia



GIS River Management

Conclusions

- G6solar, G6sulfur and SSP245 project ~2 ◦C temperature increase in the MRB, compared to the increase of 3.3 ◦C under SSP585.
- G6solar and G6sulfur modulate the MRB's climate increases of SSP585 to match SSP245, including the flood-related indices.
- G6sulfur may exacerbate dry spells of the Muda River basin (MRB) in the future, particularly during the dry months during dry months from January to May.

Future Directions

- Model uncertainty – development of regional-based GeoMIP models to capture finer scale climate processes.
- Further analysis across various sectors including agricultural, hydrological cycle, socio-economic, industry and ecological is needed.
- Further investigation using different solar geoengineering experiments at the basin-scale is needed.

https://admission.usm.my/postgraduatev1/applied-sciences-coursework/master-of-science-in-geomatic-for-disaster-risk-reduction-msc-geodrr

Thank you!

Contact

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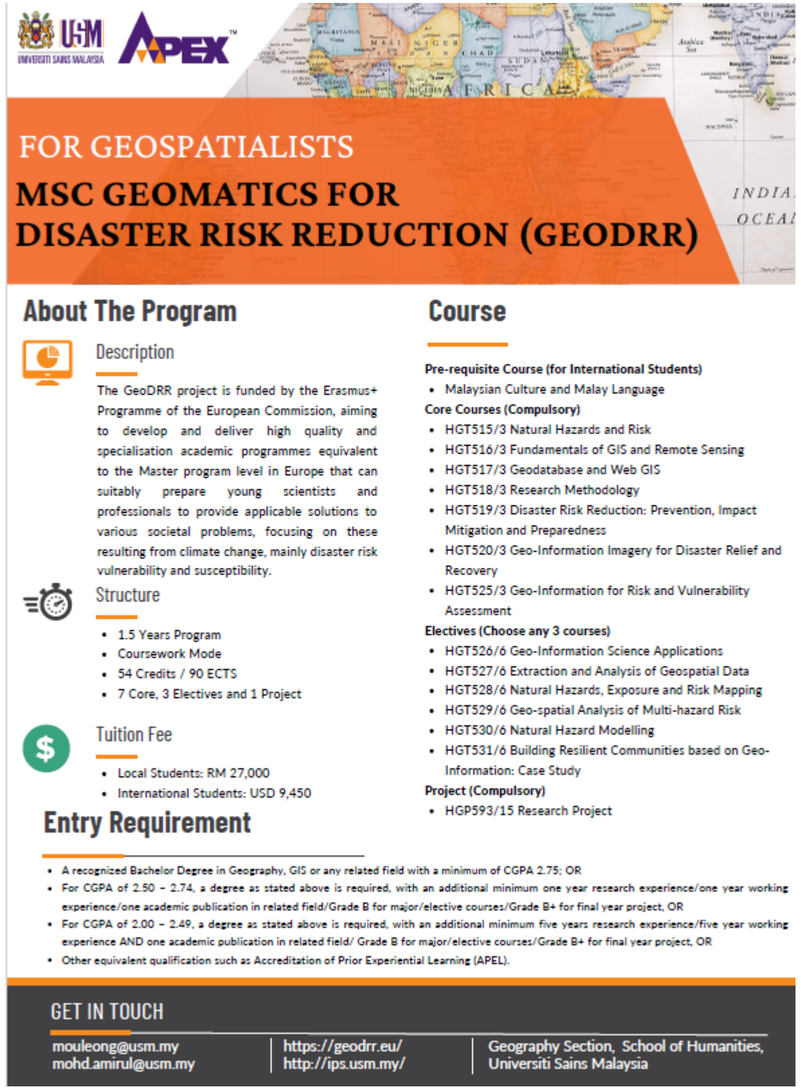
Wechat ID : MouLeong_Tan



FOR GEOSPATIALISTS

MSC GEOMATICS FOR DISASTER RISK REDUCTION (GEODRR)

About The Program

Description

The GeoDRR project is funded by the Erasmus+ Programme of the European Commission, aiming to develop and deliver high quality and specialisation academic programmes equivalent to the Master program level in Europe that can suitably prepare young scientists and professionals to provide applicable solutions to various societal problems, focusing on these resulting from climate change, mainly disaster risk vulnerability and susceptibility.

Structure

- 1.5 Years Program
- Coursework Mode
- 54 Credits / 90 ECTS
- 7 Core, 3 Electives and 1 Project

Tuition Fee

- Local Students: RM 27,000
- International Students: USD 9,450

Course

Pre-requisite Course (for International Students)

- Malaysian Culture and Malay Language

Core Courses (Compulsory)

- HGT515/3 Natural Hazards and Risk
- HGT516/3 Fundamentals of GIS and Remote Sensing
- HGT517/3 Geodatabase and Web GIS
- HGT518/3 Research Methodology
- HGT519/3 Disaster Risk Reduction: Prevention, Impact Mitigation and Preparedness
- HGT520/3 Geo-Information Imagery for Disaster Relief and Recovery
- HGT525/3 Geo-Information for Risk and Vulnerability Assessment

Electives (Choose any 3 courses)

- HGT526/6 Geo-Information Science Applications
- HGT527/6 Extraction and Analysis of Geospatial Data
- HGT528/6 Natural Hazards, Exposure and Risk Mapping
- HGT529/6 Geo-spatial Analysis of Multi-hazard Risk
- HGT530/6 Natural Hazard Modelling
- HGT531/6 Building Resilient Communities based on Geo-Information: Case Study

Project (Compulsory)

- HGP593/15 Research Project

Entry Requirement

- A recognized Bachelor Degree in Geography, GIS or any related field with a minimum of CGPA 2.75; OR
- For CGPA of 2.50 – 2.74, a degree as stated above is required, with an additional minimum one year research experience/one year working experience/one academic publication in related field/Grade B for major/elective courses/Grade B+ for final year project, OR
- For CGPA of 2.00 – 2.49, a degree as stated above is required, with an additional minimum five years research experience/five year working experience AND one academic publication in related field/ Grade B for major/elective courses/Grade B+ for final year project, OR
- Other equivalent qualification such as Accreditation of Prior Experiential Learning (APEL).

GET IN TOUCH

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https://geodrr.eu/
http://ips.usm.my/

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Universiti Sains Malaysia