METEOROLOGICAL SERVICE SINGAPORE

Climate Change Impacts on Food Security

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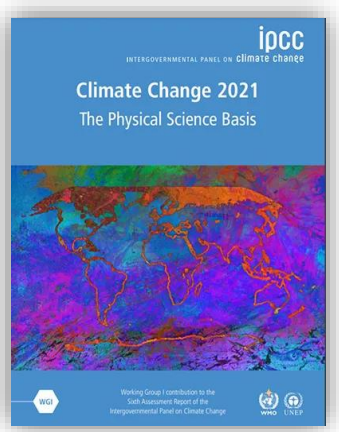
Presentation at National Press Club

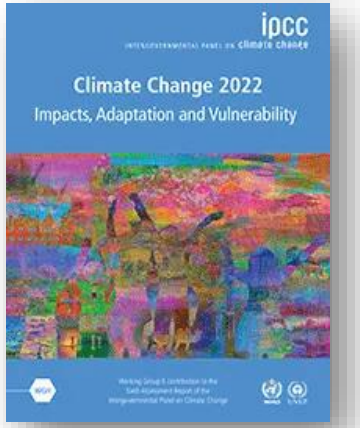
July 2023

Outline

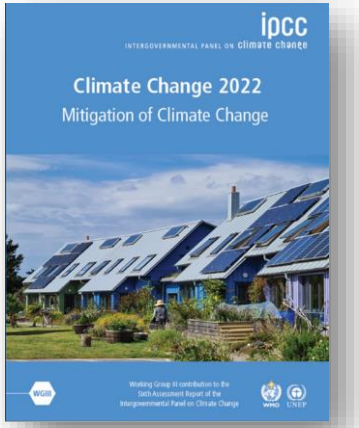
- Context – IPCC WG-II messages
- Singapore focus
- Singapore's 3rd National Climate Change Study



Physical Science Basis

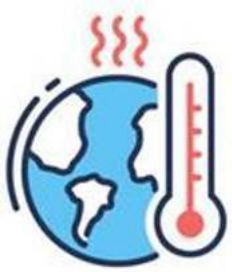


Impacts, Vulnerability, Adaptation



Mitigation

Key IPCC AR6 WG-I Findings



1. Global Mean Surface Temperature

- Global warming levels of 1.5°C and 2°C above pre-industrial levels **will be exceeded by the end of the 21st century** under all but the two lowest CO2 emission scenarios i.e. SSP1-1.9 and SSP2-2.6.
- The central estimate of crossing the 1.5°C global warming level lies in the early 2030s, and would be even earlier for SSP5-8.5.

2. Carbon Budget

- To limit global warming to 1.5 °C, the **world needs to achieve net zero by around 2050**, with a carbon budget of 500 $GtCO_2$ left.
- Annual global emissions today stand at about 50 $GtCO_2$ per annum (Climate Action Tracker)

3. Global Mean Sea Level (GMSL)

- GMSL rates has **accelerated**.
- While SLR projections are **comparable to AR5,** there might be a disproportionate impact on low-lying states in the tropics.

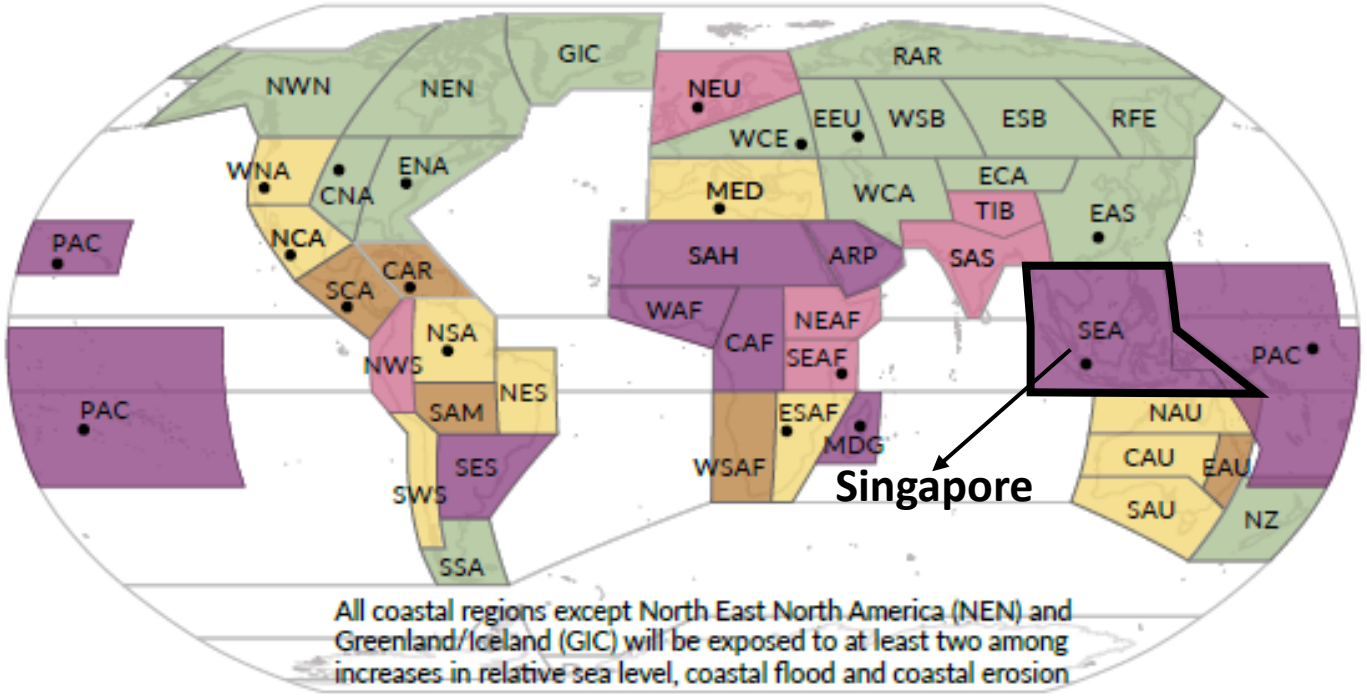
4. Extreme Weather Events

- Every region will increasingly experience concurrent changes in multiple climatic impact drivers, with **wider set of changes occurring at 2°C compared to 1.5°C** in the majority of regions.

Key Findings – Extreme Weather Events

- **There are specific changes to climatic impact-drivers* for each region**
- South-east Asia (SEA) will experience an increase in mean temperature, increase in extreme heat, increase in mean precipitation and pluvial flooding

*Climatic impact-drivers are physical climate system conditions (e.g. means, events, extremes) that affect an element of society or ecosystems.



1) Hotter and drier

2) Hotter and drier and in some regions wetter extremes

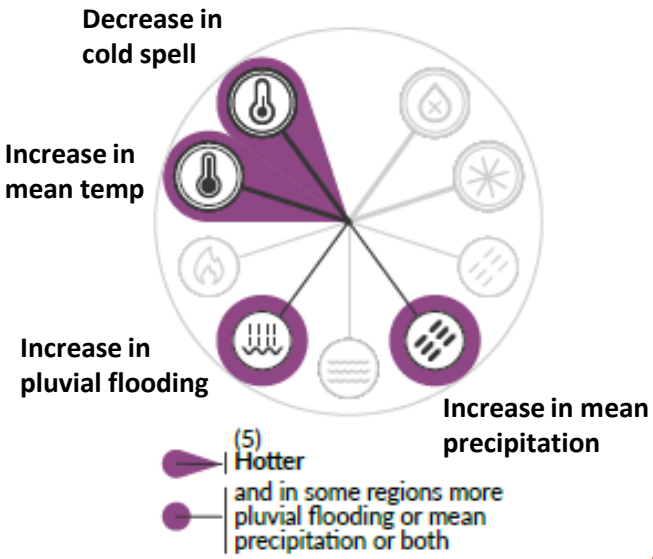
3) Hotter and wetter extremes and in some regions more precipitation or fire weather

4) Hotter and wetter and in some regions more flooding

5) Hotter and in some regions wetter extremes or more precipitation

6) Increase in Tropical cyclones intensity or Severe winds

For SEA



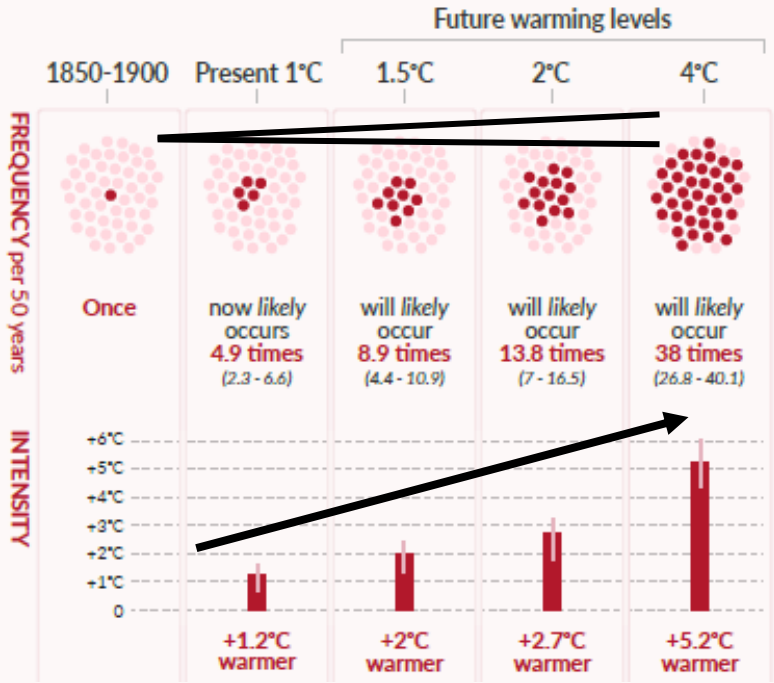
Key Findings – Extreme Weather Events

- The frequency and intensity of extreme weather events will grow as global warming intensifies.

Extreme Temperature* over land

50-year event

Frequency and intensity of an extreme temperature event that occurred **once in 50 year** on average in a climate without human influence



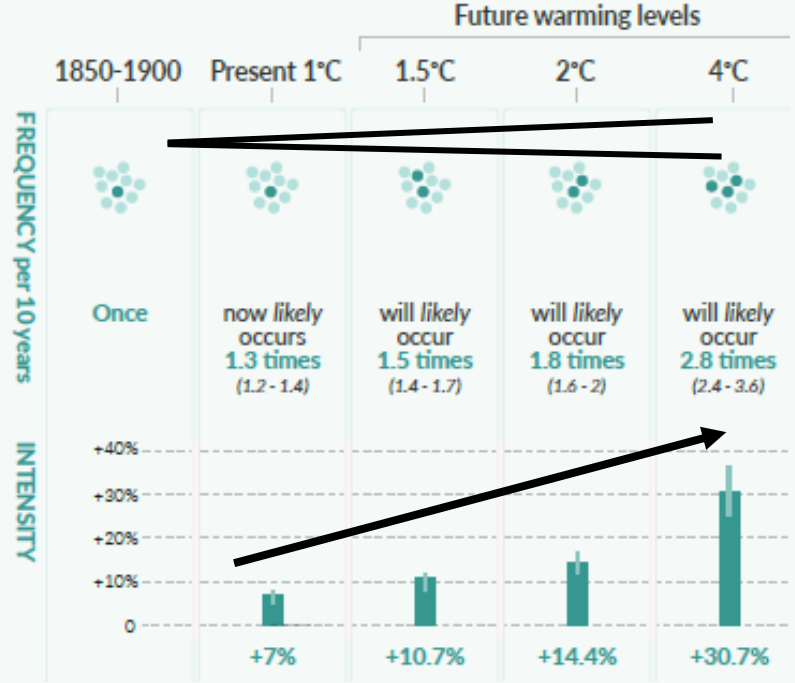
Increase Frequency and Intensity of Extreme Temperature experienced with each degree warming

* Daily maximum temperatures that were exceeded on average once in 50 years [reference period: 1851 – 1900]

Extreme Precipitation^ over land

10-year event

Frequency and intensity of an extreme precipitation event that occurred **once in 10 year** on average in a climate without human influence



Increase Frequency and Intensity of Extreme Precipitation experienced with each degree warming

^ Daily precipitation amount that was exceeded on average once in a decade during the reference period 1851–1900

IPCC AR6 – WG-II

1. Increasing weather and climate extreme events *"have exposed millions of people to acute **food insecurity** & reduced **water security**."*

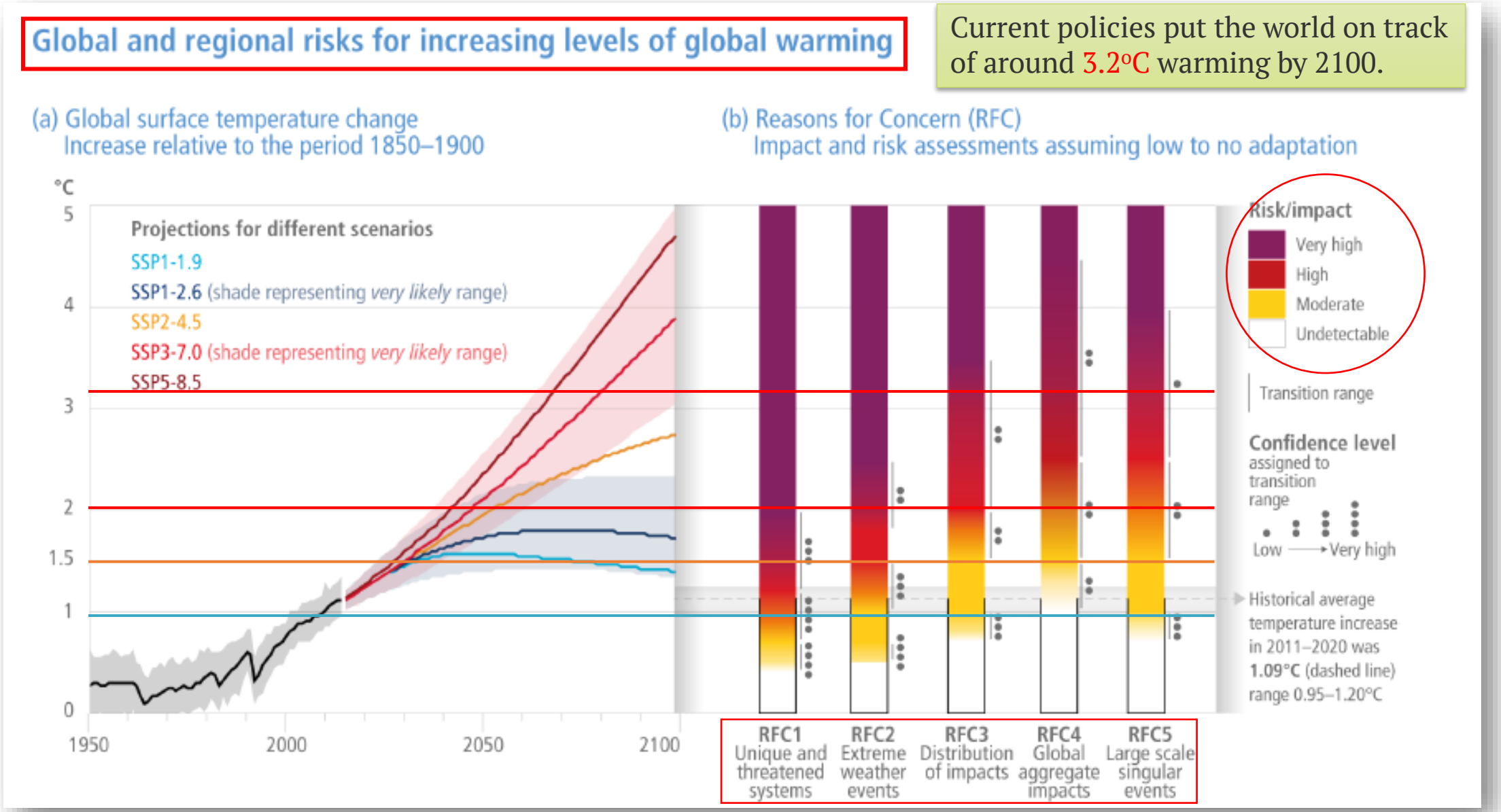
   - *Significant impacts seen in Africa, Asia, South America & on small islands.*

2. Terrestrial and freshwater species *"at very high risk of extinction" - up to 14% at 1.5^{o}C*

   - *This rises to up to 18% at 2^{o}C*

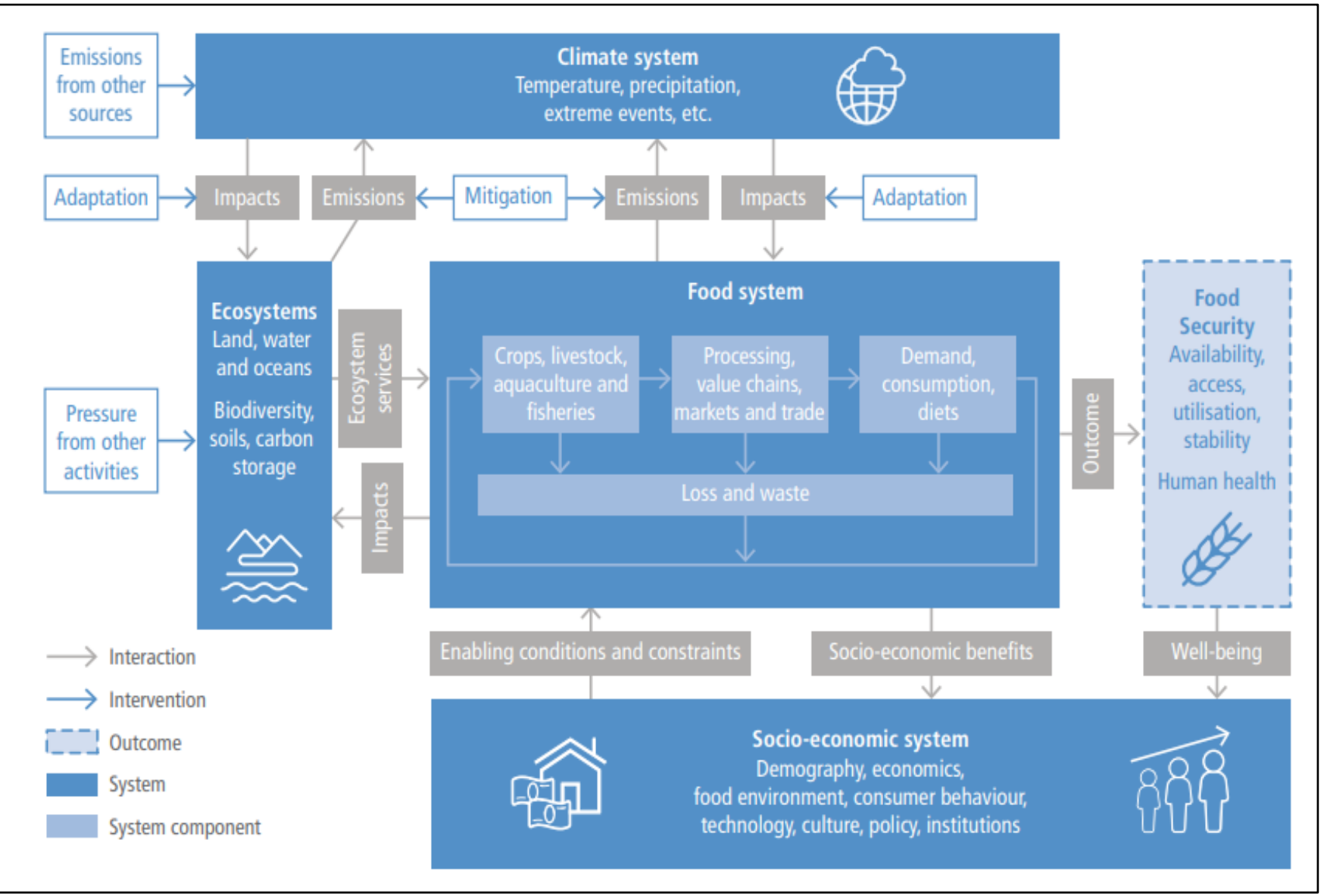
   - *Up to 29% at 3^{o}C.*

IPCC AR6: Burning Ambers & Reasons for Concern



Compared to **AR5 (2014): Climate risks** are now regarded as **higher** at **lower temperatures** – and likely to happen **sooner** & with **greater intensity.**

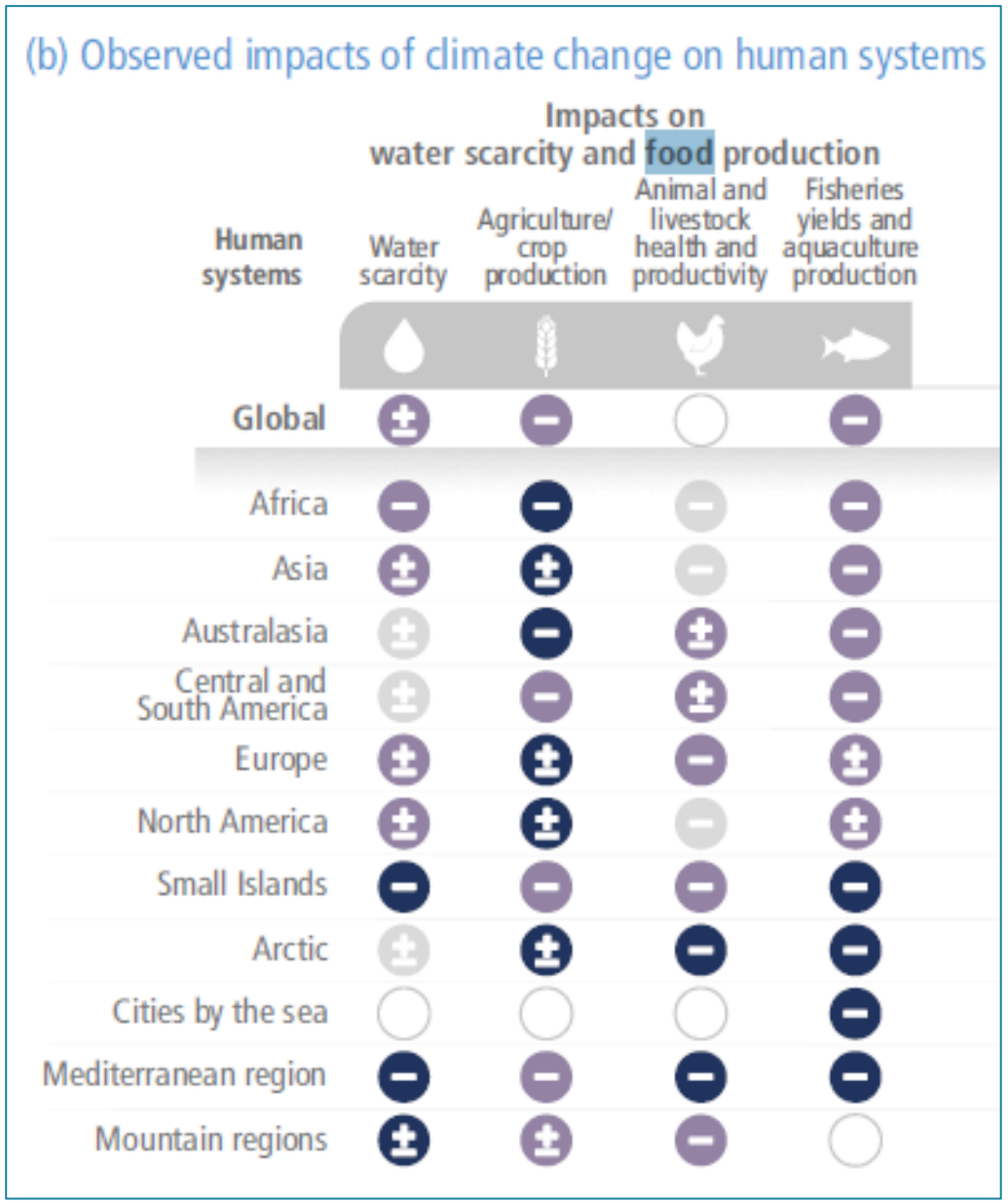
Linkages of Food System with Climate System



- Interlinkages between Climate system, Food system, Ecosystem, and Socio-economic system:
  - **Food security** is a tangible outcome of a food system and is dependent upon climate & ecosystems via key socio-economic factors.
  - Adaptation measures can reduce the negative impacts of climate change on the food system
  - Mitigation measures can promote good agricultural practices and soil health to reduce greenhouse gas (GHG) emissions.

Linkages of food system with various factors that operates at the global and regional level (Source: IPCC WG II AR5, Chapter 5)

IPCC-WG-II: OBSERVED food security issues



WG-II-SPM:

- *Climate change including increases in <u>frequency and intensity of extremes</u> have reduced food and water security, hindering efforts to meet Sustainable Development Goals (high confidence).*
- *Although overall agricultural productivity has increased, climate change has slowed this growth over the past 50 years globally (medium confidence), related negative impacts were mainly in mid- and low latitude regions but positive impacts occurred in some high latitude regions (high confidence).*

Figure SPM.2

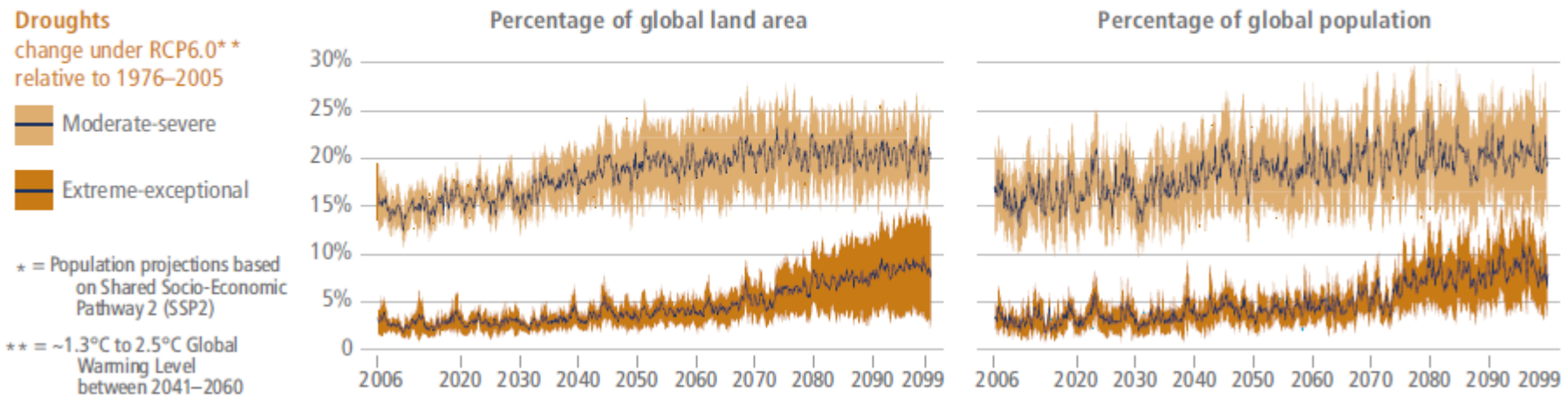
IPCC-WG II: Future changes

- Climate change will increasingly put pressure on food production and access, especially in vulnerable regions, undermining food security and nutrition (*high confidence*).

- Increases in frequency, intensity and severity of **droughts, floods and heatwaves**, and continued **sea level rise** will increase risks to food security (*high confidence*) in vulnerable regions from moderate to high between 1.5°C and 2°C global warming level, with no or low levels of adaptation (*medium confidence*).

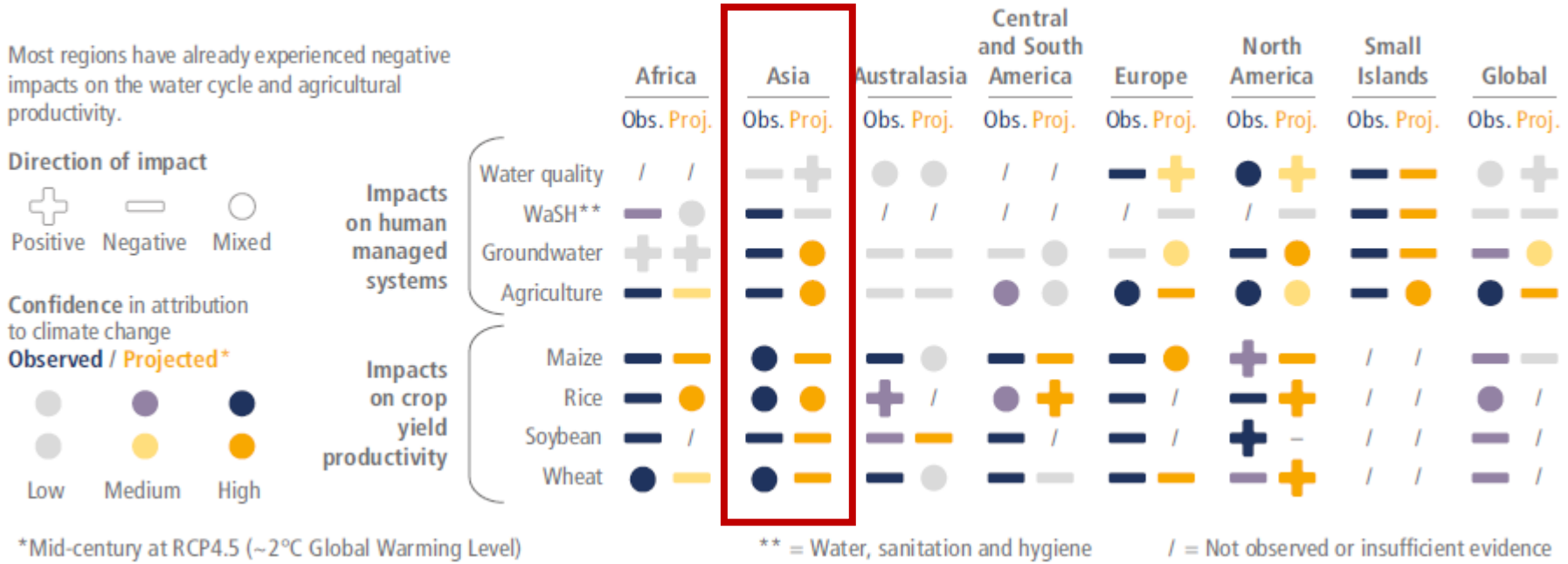
- At 2°C or higher global warming level in the mid-term, food security risks due to climate change will be more severe, leading to malnutrition and micro-nutrient deficiencies, concentrated in Sub-Saharan Africa, South Asia, Central and South America and Small Islands (*high confidence*).

(b) By the late 21st century the share of the global land area and population* affected by combinations of agricultural, ecological and hydrological droughts is projected to increase substantially.



Future Droughts:
- Land
- Population

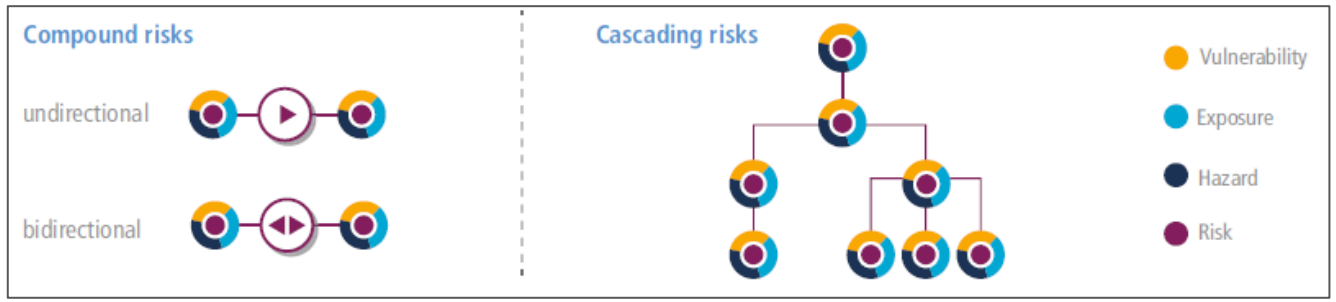
(c) Observed and projected impacts from climate change in the water cycle for human managed systems and crop yield productivity.



Water Cycle and Crops:
- Observed
- Future

Figure TS.6 FOOD-WATER

Complex, Compound and Cascading Risks



- Increasing concurrence of heat and drought events are causing crop production losses and tree mortality (high confidence).
- Above 1.5°C global warming increasing concurrent climate extremes will increase risk of simultaneous crop losses of maize in major food-producing regions, with this risk increasing further with higher global warming levels (medium confidence).

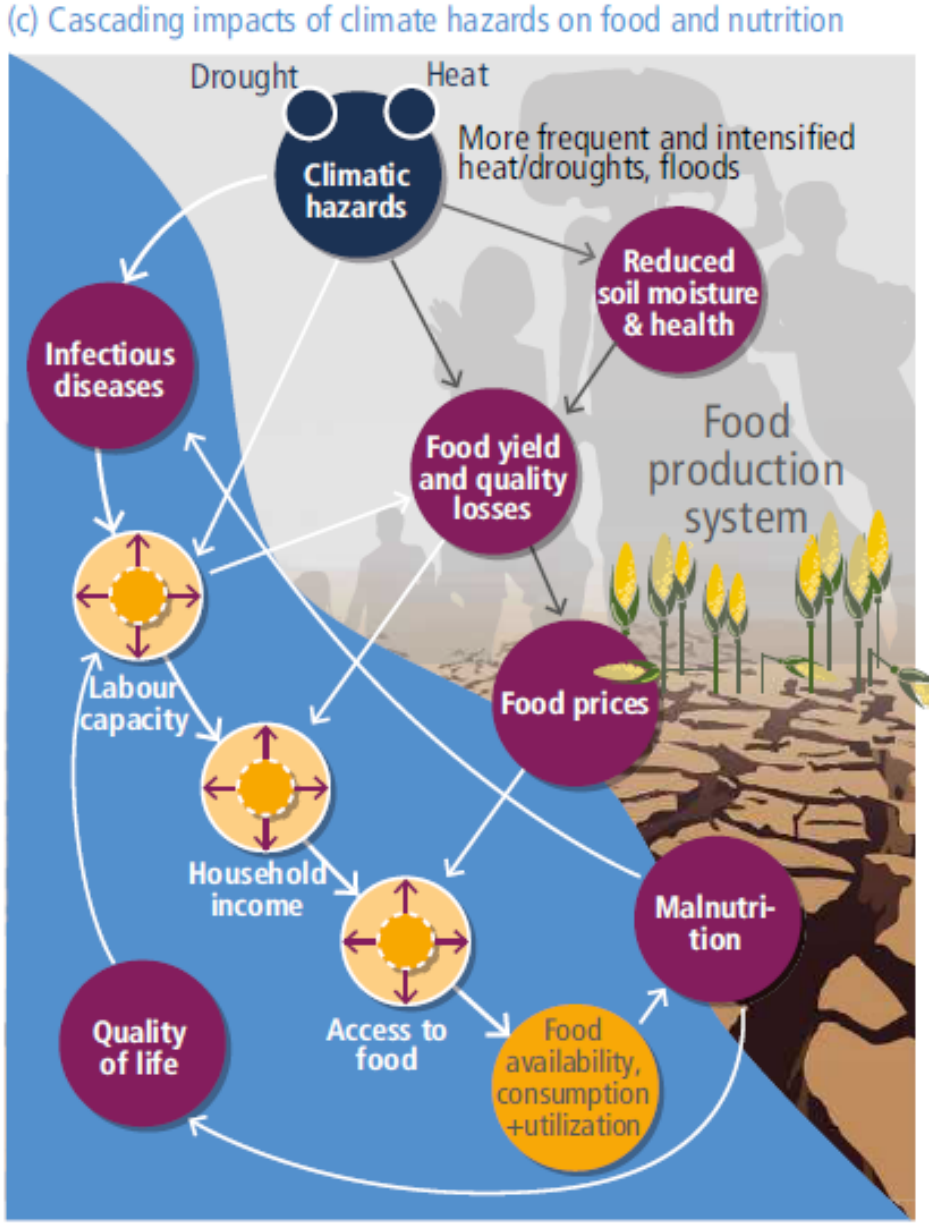


Figure TS.10 COMPLEX RISK

Illustration of some connections across key risks

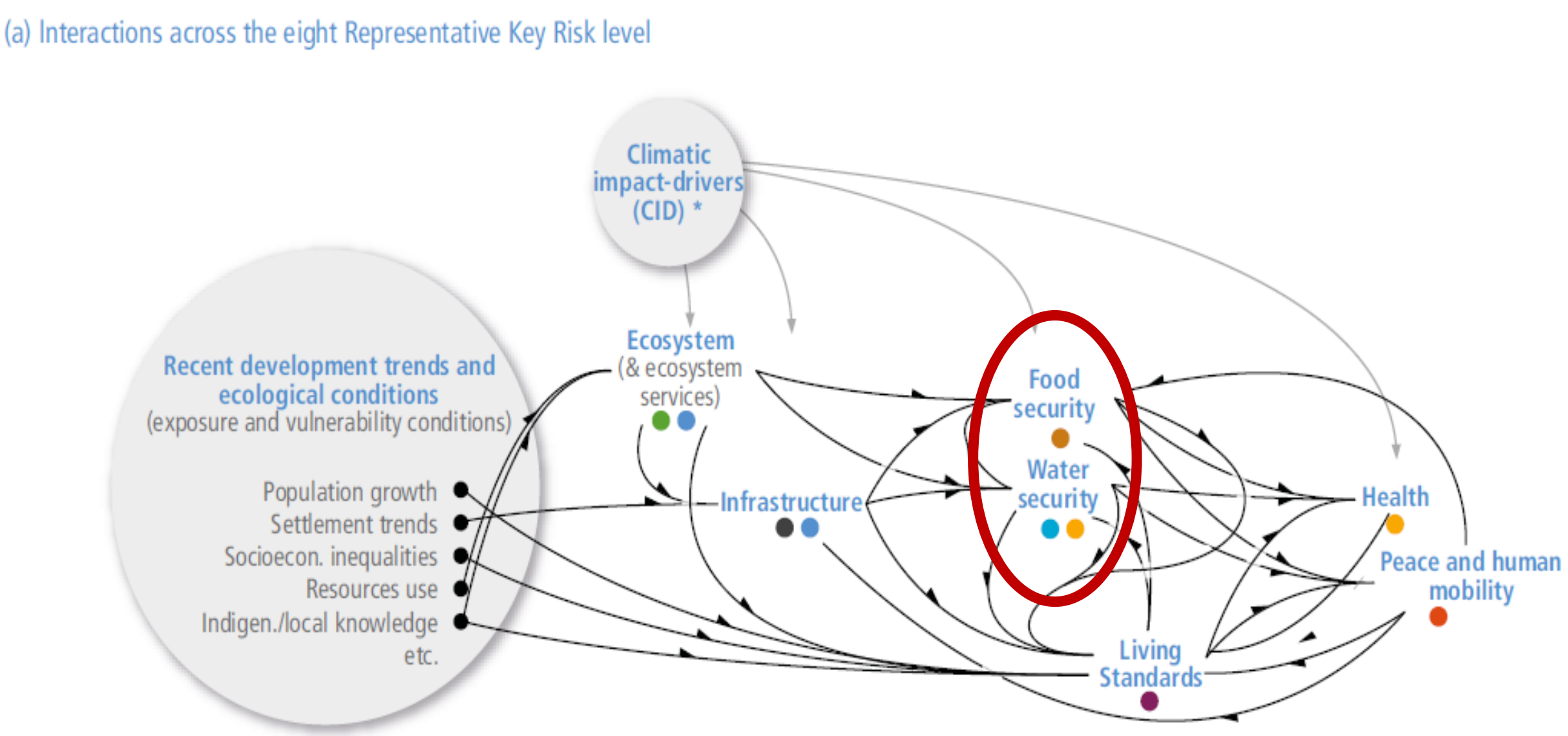
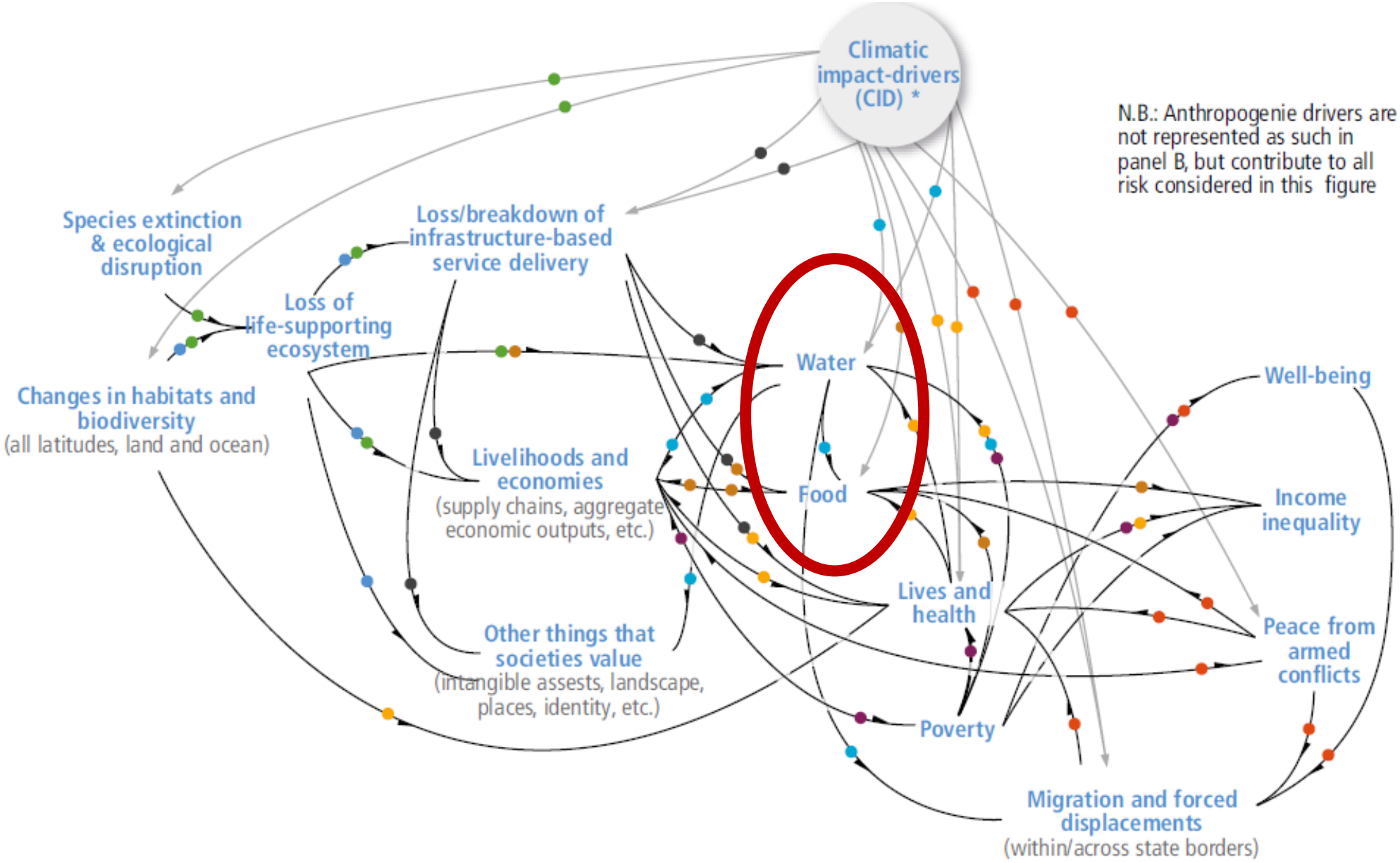


Figure TS.AII.3

Illustration of some INTERACTIONS at key risk level

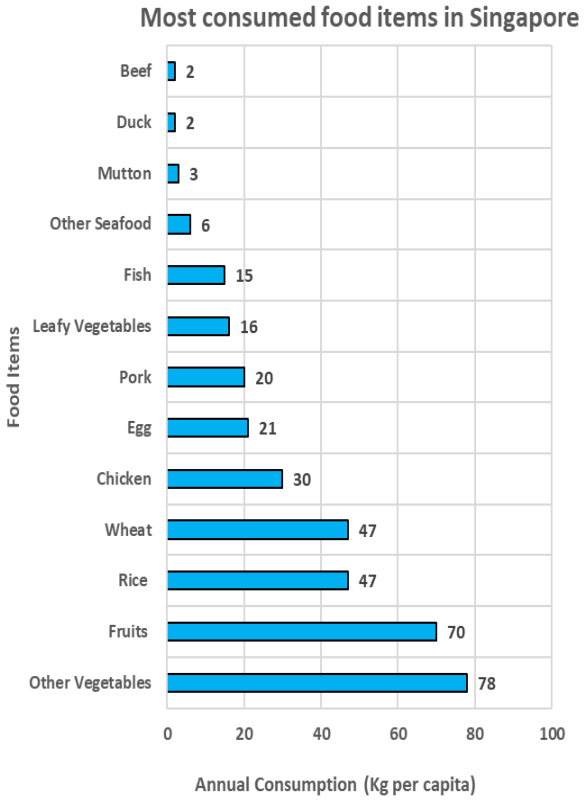


Outline

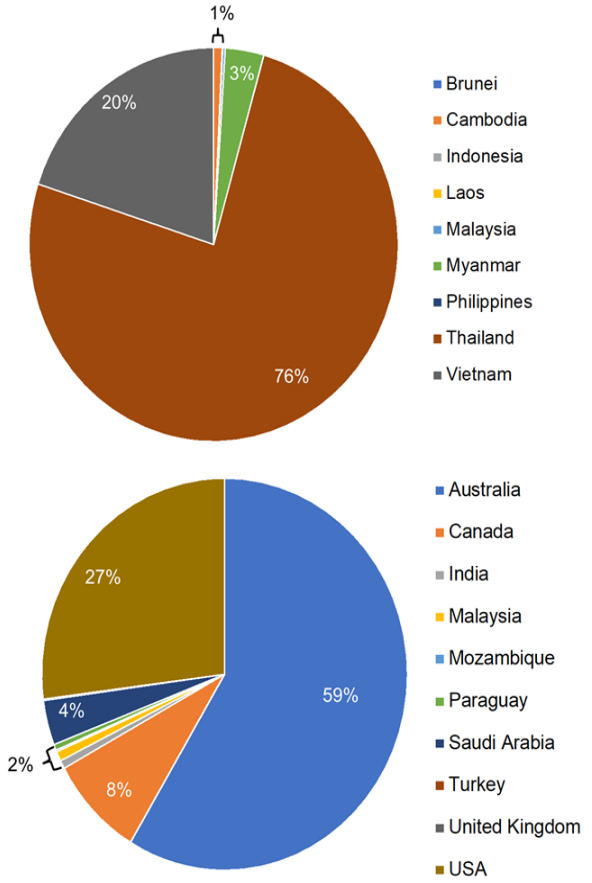
- Context – IPCC WG-II messages
- **Singapore focus**
- Singapore's 3rd National Climate Change Study

SINGAPORE focus

Percentage contribution of the countries that supply total Rice and Wheat to Singapore



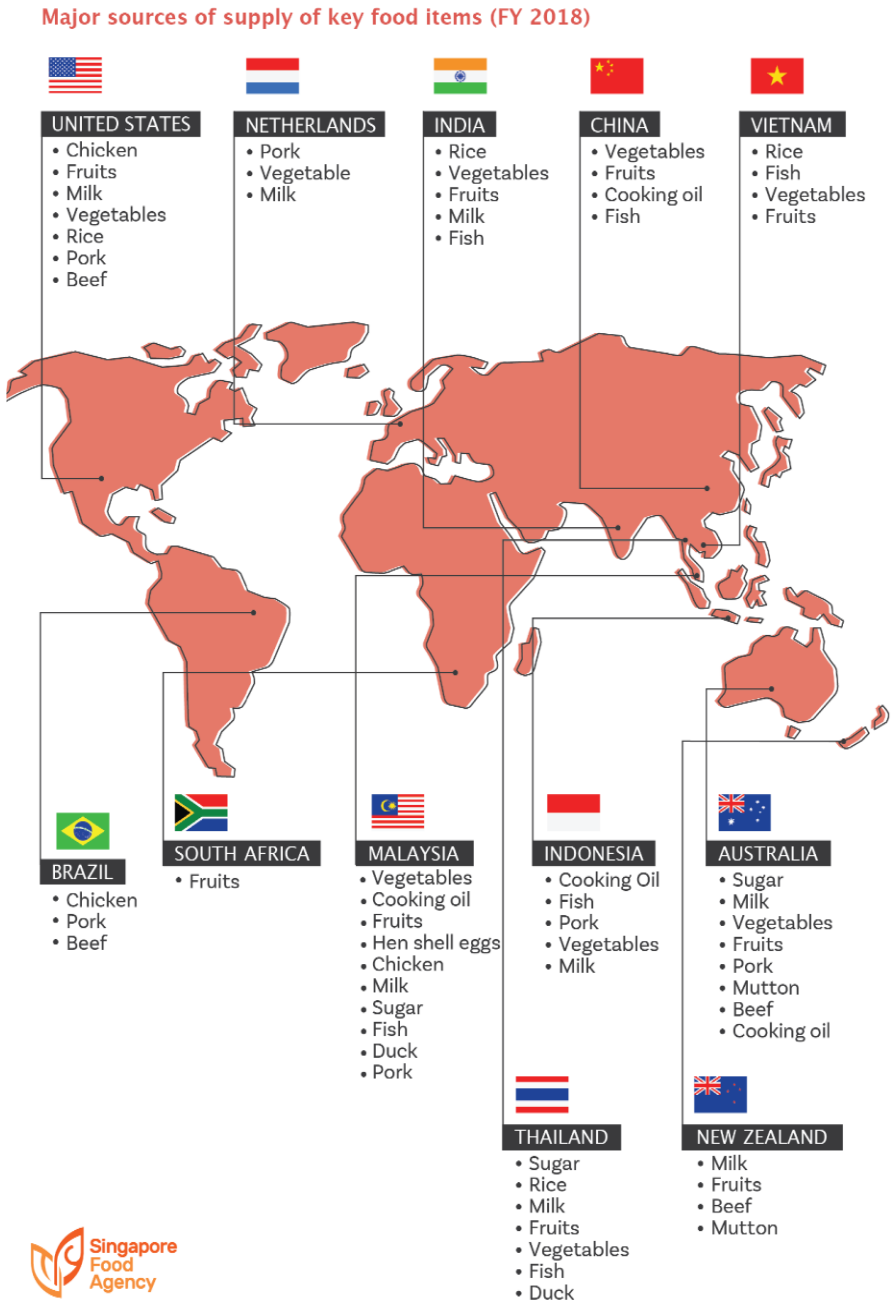
*Annual food consumption (kg per capita) of specific food item in Singapore (*Data Source: Loong Tan et al., 2020)



Imports of rice and wheat into Singapore from 1986-2020 (Data Source: FAOSTAT).

- In Singapore, vegetables (78 kg/capita/year) and fruits (70 kg /capita/year) are highly consumed.
- Rice and wheat (both 47 kg/capita/year) are the most commonly consumed cereal staple foods.
- In the last 35 years, rice has been primarily imported from Thailand (76%), followed by Vietnam (20%), with wheat imported mostly from Australia (59%) & the USA (27%) .
- From decadal analysis (not shown) it is observed that rice imports from Vietnam have increased from 6% to 38% in the last three decades.
- Wheat imports from the USA has doubled (38%) in the recent decade.

SINGAPORE focus



Major Source of supply of key food items in Singapore (Source: https://www.sfa.gov.sg/)

- With a land area of only about 800 km_2, Singapore imported over 90% of its food needs in 2019 from over 170 countries worldwide (SFA, 2020)
- SFA plan “30 by 30”

30 by 30

To develop capability and capacity of the local agri-food industry to produce 30% of nutritional needs by 2030

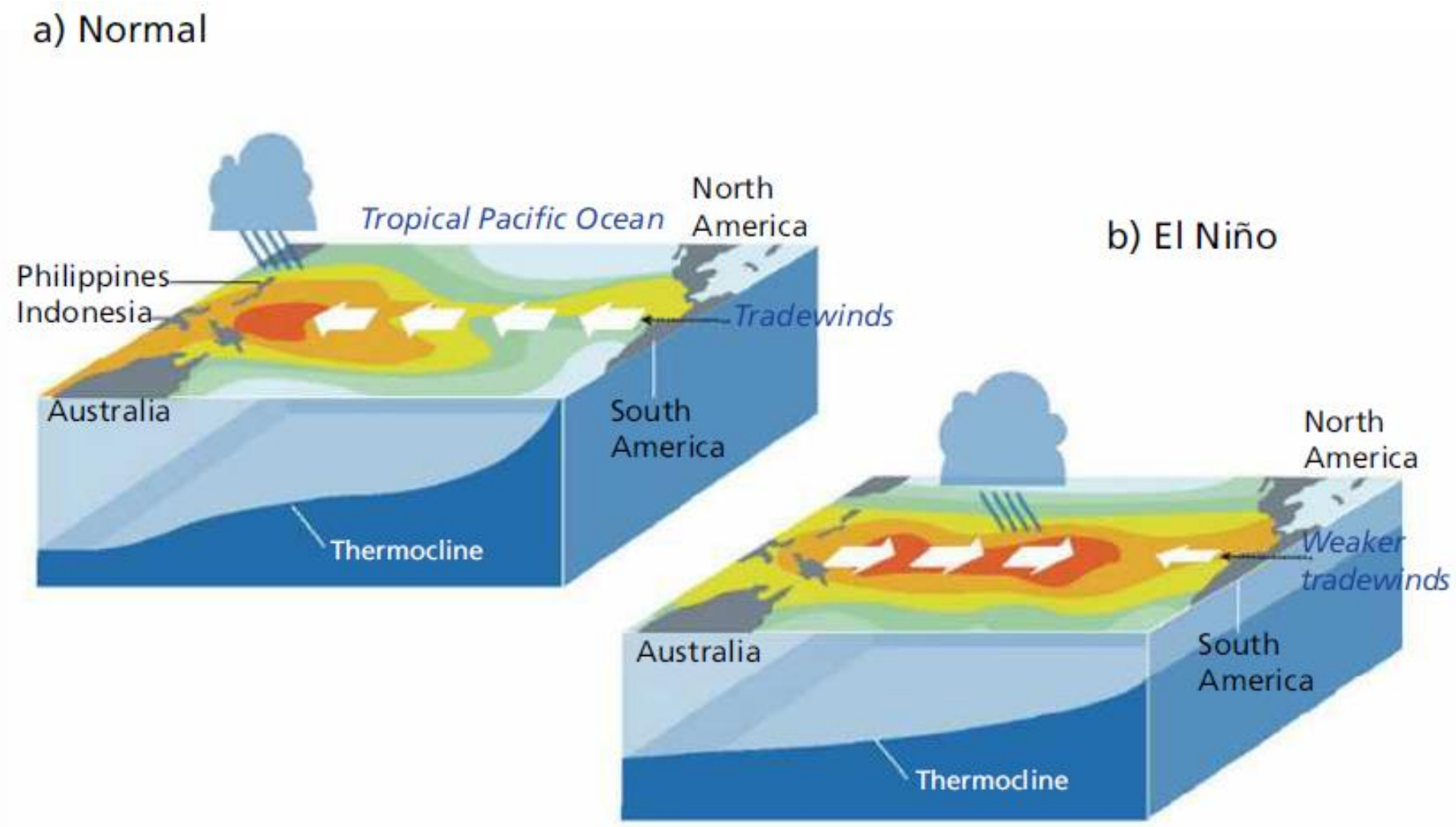
Influence of Climate Drivers on Food Production

1. **Climate drivers that directly or indirectly influences food production:**
   - -El Nino Southern Oscillation (ENSO)
   - -Indian Ocean Dipole (IOD)
   - -North Atlantic Oscillation (NAO)
   - -Pacific Decadal Oscillation (PDO)

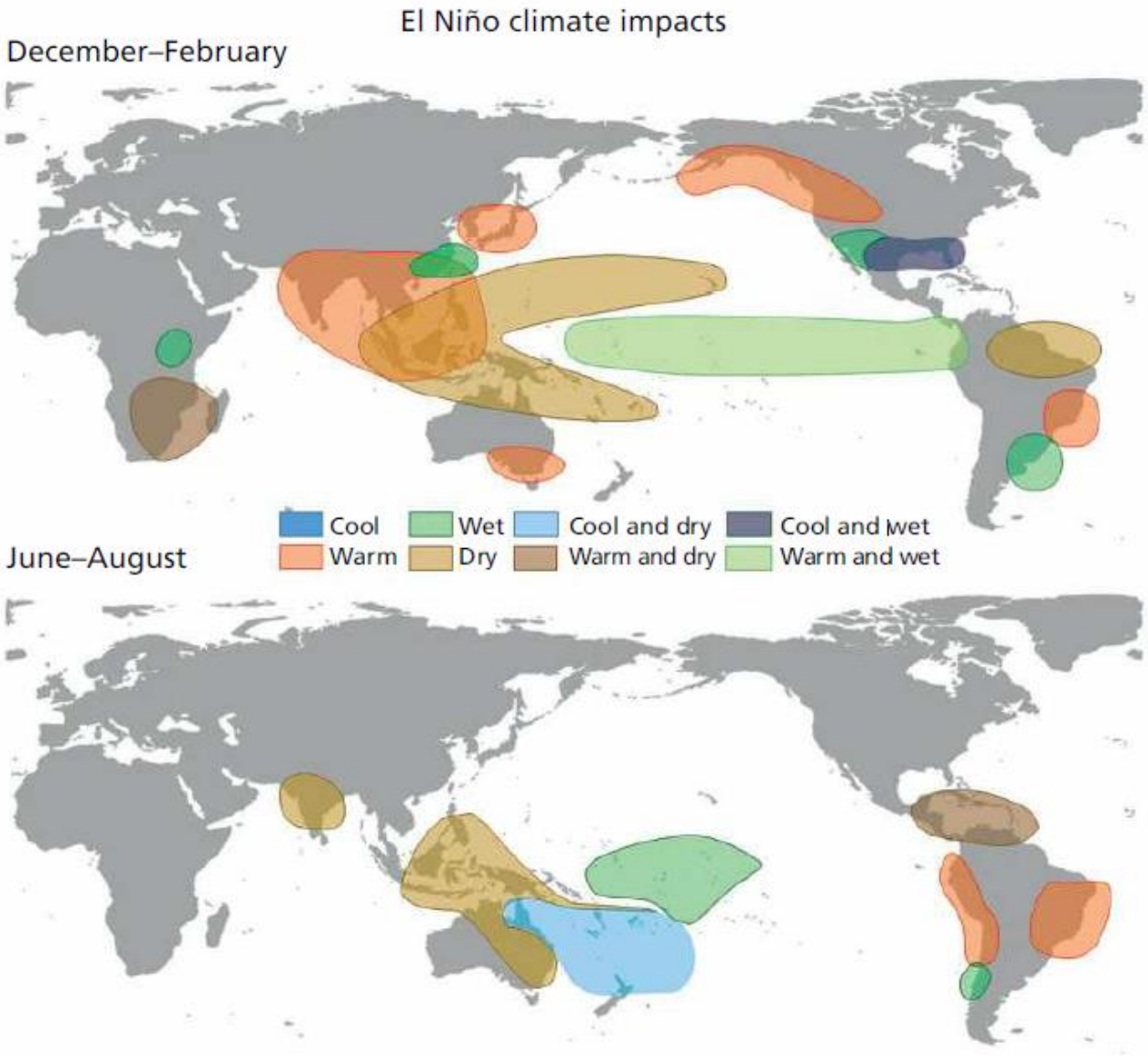
2. **Impact of ENSO on Food Production:**

   - ENSO have a significant impact on rice and wheat production.
   - The observed relationships suggest that year-to-year weather-related variations of Thailand's rice production at a country level has varied during ENSO event (Limsakul, 2019).
   - In Australia, it had the highest negative impact as compared to other countries including the United States, Argentina, Canada, the EU, Russia, Ukraine, and Kazakhstan (Gutierrez, 2017).

ENSO – basic mechanism



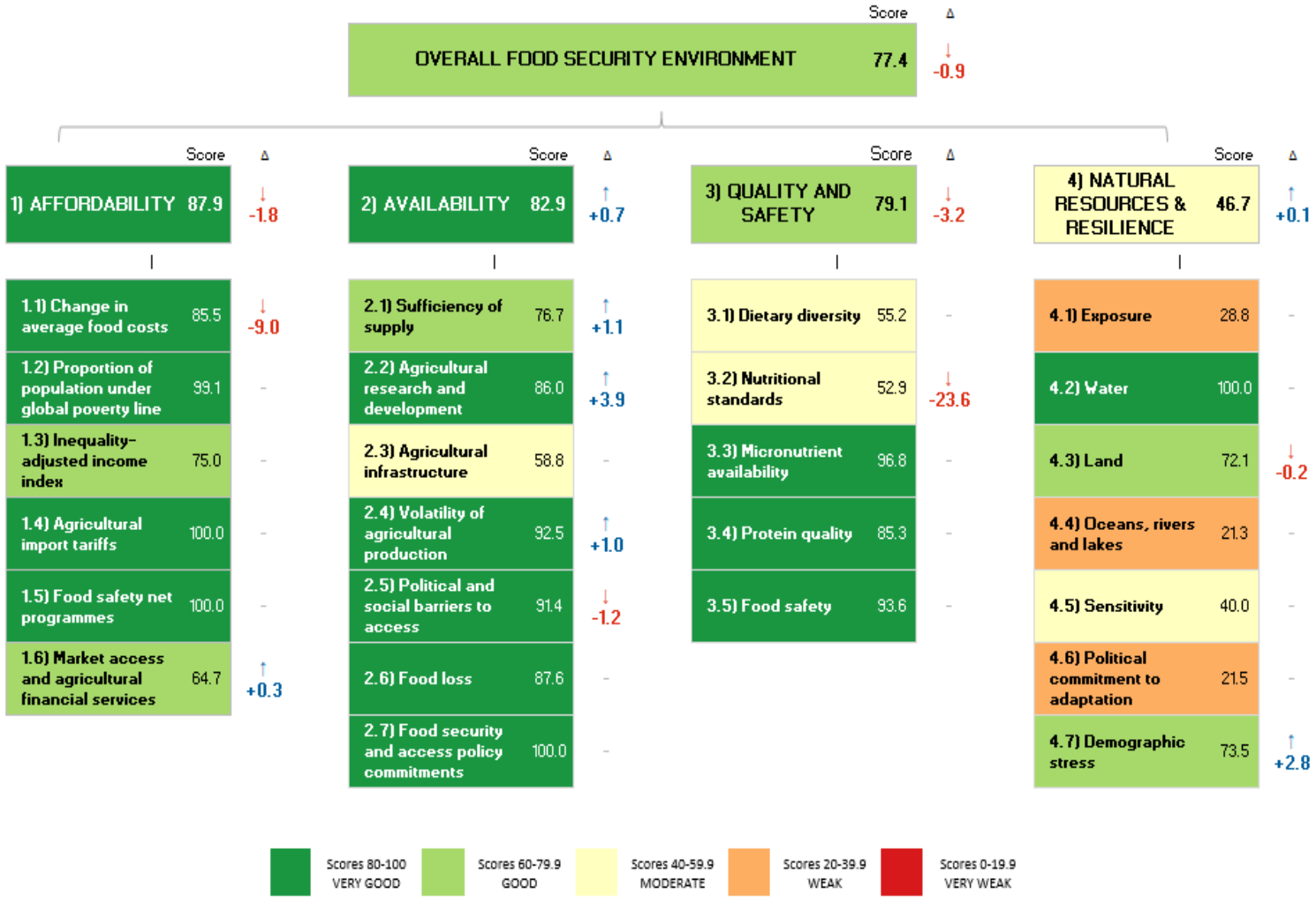
ENSO – global impacts



ENSO future changes:

- Climate change is very likely to influence the mean climate of the Pacific region.
- The inability of climate models to realistically simulate the present-day climate and ENSO properties hampers the reliability of climate projections.
- As a consequence, it is not yet possible to confidently assess if and how ENSO activity (amplitude, frequency, pattern) will change in the future.
- Despite the absence of consensus, recent studies suggest a potential doubling of the frequency of extreme El Niño and La Niña events.

Summary of Singapore's performance on the Global Food Security Index-2021



- Global Food Security Index (GFSI):
  - The model considers four major issues of food security:
    - Affordability
    - Availability
    - Quality and Safety
    - Natural Resources & Resilience
  - The model measures food security using 68 indicators for 113 countries.
- Key results:
  - Globally, Singapore ranks 15th
  - Regionally, Singapore ranks 2nd highest amongst the Asia Pacific (1st is Japan)
  - The strongest Indicators of Singapore lies within affordability (87.9) and availability (82.9)
  - The weakest indicators for Singapore lies in Natural Resources and Resilience (46.7)

Note: GFSI calculation is based on 0 to 100 scale, with 0 meaning country performs worse and 100 meaning country performs best.

Data Source: Economist Intelligence Unit., 2021

SUMMARY -1

- Evidence shows that climate change impacts on food security is already emerging in Southeast Asia and globally.
- Based on United Nation's Food and Agricultural Organization (UNFAO):
    - Rice Import to Singapore: Thailand (56%)+ Vietnam(38%) = 94% of the total rice
    - Wheat Import to Singapore: Australia (57%) + USA (35%) = 92% of the total wheat
    - Over the past few decades, Vietnam and the USA have evolved as the second largest importers of rice and wheat respectively.
- Singapore government has consistently planned and prepared for possible crises to ensure resilience in Singapore's food supply chain and security through a combination of short- and long-term strategies.

Outline

- Context – IPCC WG-II messages
- Singapore focus
- Singapore's 3rd National Climate Change Study

Supporting climate change impacts research

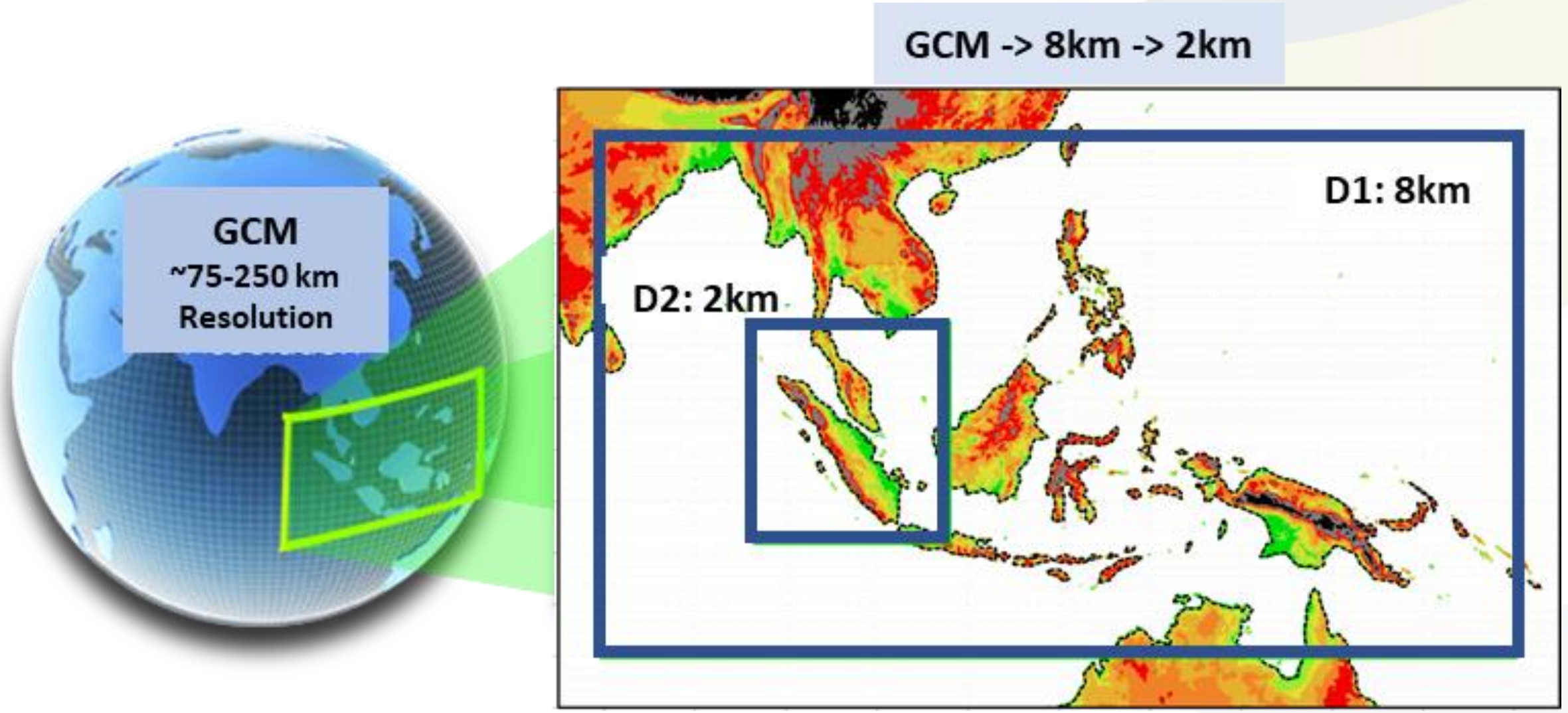
- V3 – Singapore's Third National Climate Change Study
- CCRS will produce the next set of high resolution climate change projections for Singapore and the SEA region in line with IPCC AR6
- Enable impact modeling and subsequent adaptation planning for a climate-resilient Singapore (and SEA region)
- Advance the current state of understanding of climate variability and change over Singapore and the larger SEA region

NEW regional climate projections for impact studies

	V3 Specs	Comments
Global climate model	CMIP6	Latest and best global models as per IPCC AR6
Regional climate model	SINGV-RCM	NEW regional climate model
Future scenarios	SSP1-2.6 SSP2-4.5 SSP5-8.5	IPCC AR6 scenarios for low, medium and high emission pathway
Spatial resolution	8km (domain-1) 2km (domain-2)	Very high resolution over large domains
Temporal resolution	hourly	Uniquely high temporal resolution of data (hourly)

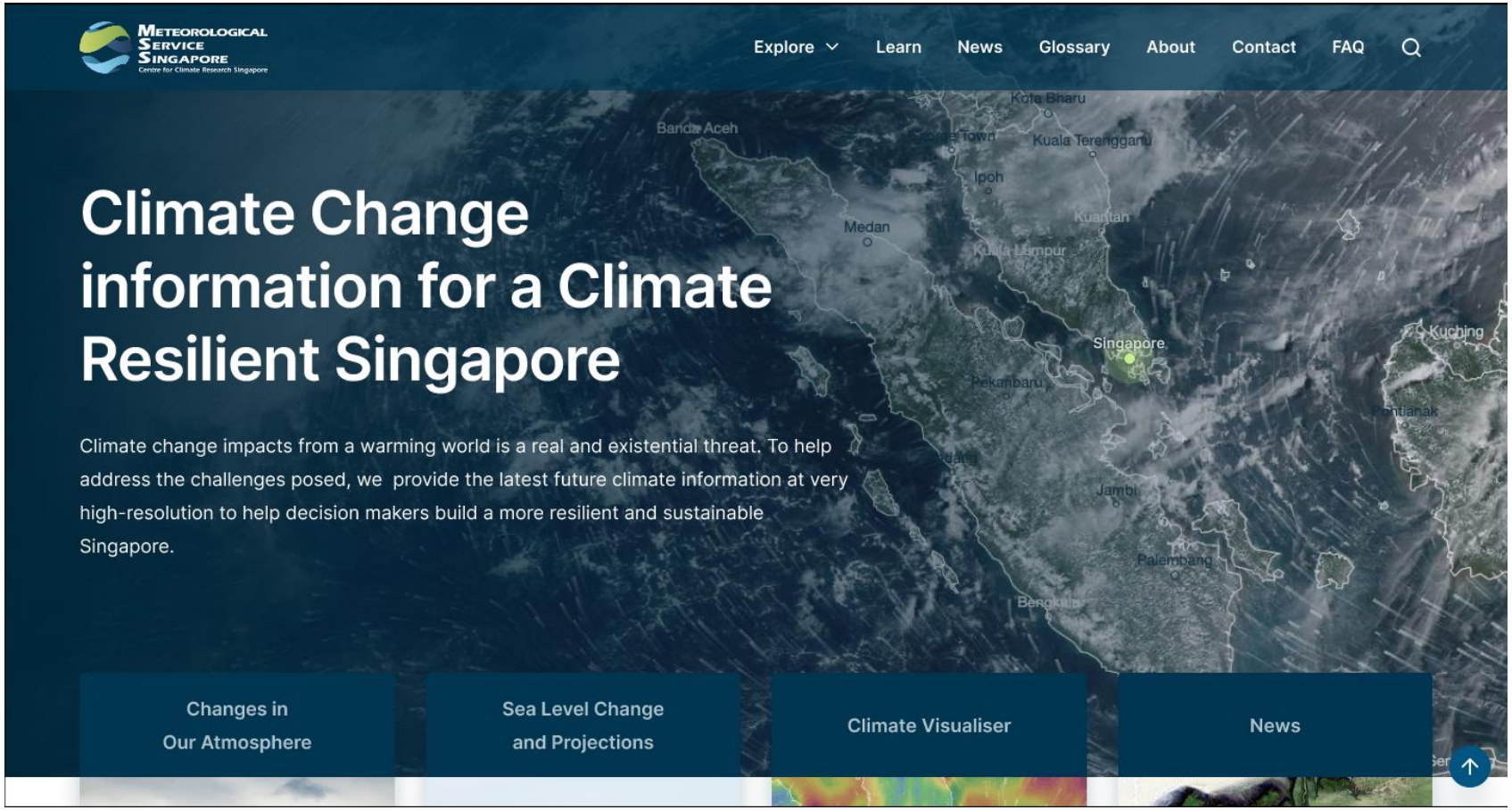
CMIP6: Coupled Model Intercomparison Project Phase 6
SSP1-2.6: “Taking the green road” scenario with low challenges to mitigation and adaptation
SSP2-4.5: “Middle of the road” scenario with medium challenges to mitigation and adaptation
SSP5-8.5: “Fossil-fueled development” scenario with high challenges to mitigation and low challenges to adaptation

Climate Change data available over large SEA domain



NEW Visualization Portal released in Nov-2023

- Will be mobile-friendly
- Be unveiled by Min. on 22 Nov during the V3 Public Launch
- Accessed via the MSS-Int website
- ~4000 images
- Interactive selection options
- Figure downloads (PNG)
- Stakeholder + Science Reports
- V3 on a page
- V3 brochures + Videos
- Related News Items
- Glossary
- Science Publications



Ongoing research based on this data

Leveraging on V3 climate projections for Singapore and the Southeast Asian region to conduct food security analysis:

- Plans underway to work with UNFAO and their web-based tool for agriculture and climate change impacts
- Analysis of the interlinkages between climate change & food security in Singapore & Southeast Asia.
- Evaluation of the resilience of imported staple foods, such as rice from Thailand & Vietnam, in the context of climate change risk.
- Providing localized and relevant climate information to farms growing vegetable crops, such as tomatoes, in Singapore.
- Contributing to the national decision-making process to strengthen Singapore's food security system by 2030 through a collaboration with SFA on climate adaptation solutions.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Thank You