SIXTH ASSESSMENT REPORT
Working Group I – The Physical Science Basis
Working Group II – Impacts, Adaptation and Vulnerability
Working Group III - Mitigation

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INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

Sixth Assessment Report of the IPCC: Gaps and opportunities for the next cycle

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VI Convection-Permitting Climate Modeling Workshop

September 8th, 2022

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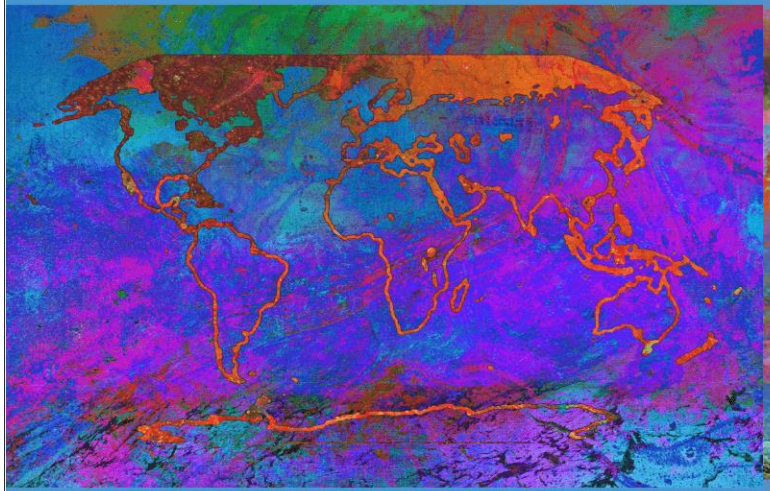
Climate Change 2021

The Physical Science Basis



WGI

Working Group I contribution to the
Sixth Assessment Report of the
Intergovernmental Panel on Climate Change

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Climate Change 2022

Impacts, Adaptation and Vulnerability

Summary for Policymakers

WGII

Working Group II contribution to the
Sixth Assessment Report of the
Intergovernmental Panel on Climate Change

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[Credit: Yoda Adaman | Unsplash]

> It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe.

Extreme heat

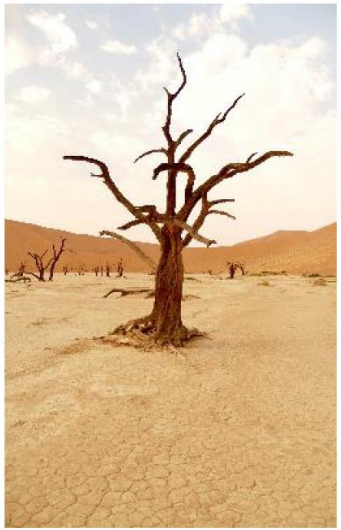
More frequent

More intense

Heavy rainfall

More frequent

More intense



Drought

Increase in some regions

Fire weather

More frequent

Ocean

Warming
Acidifying
Losing oxygen

Photo Credits from left: 1. Luiz Guimaraes 2. Jonathan Ford 3. Peter Burdon 4. Ben Kuo 5. NOAA

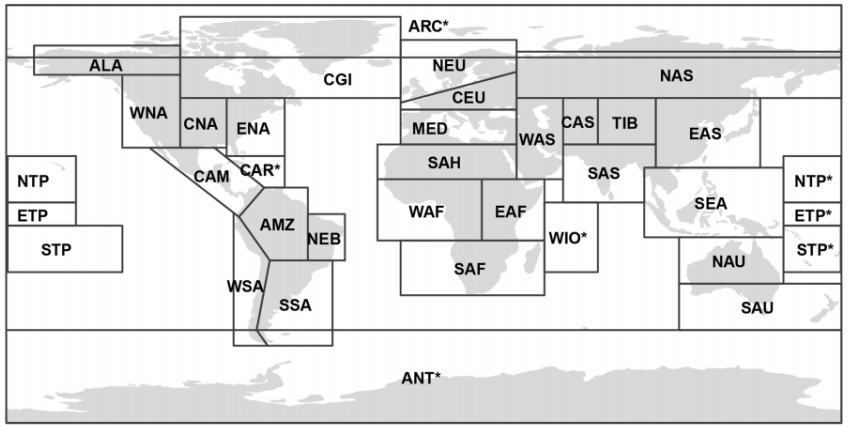
[Credit: Hong Nguyen | Unsplash]

“Climate change is already affecting every region on Earth, in multiple ways.

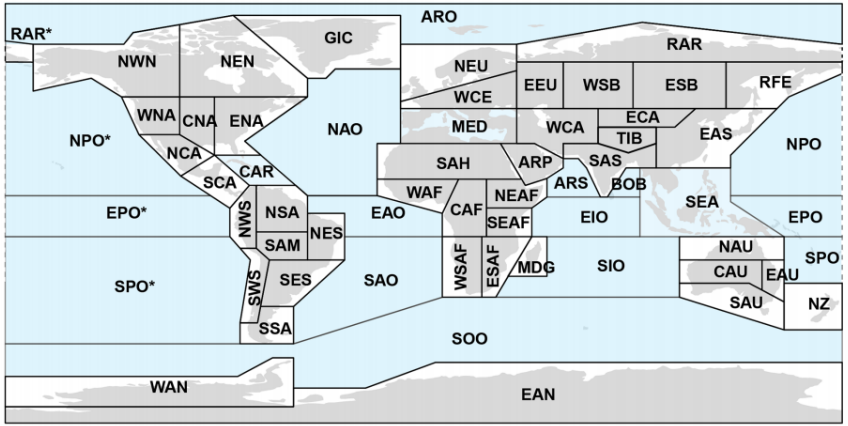
The changes we experience will increase with further warming.

Regions: AR6 vs. AR5

(a) IPCC WGI reference regions (v3, AR5)



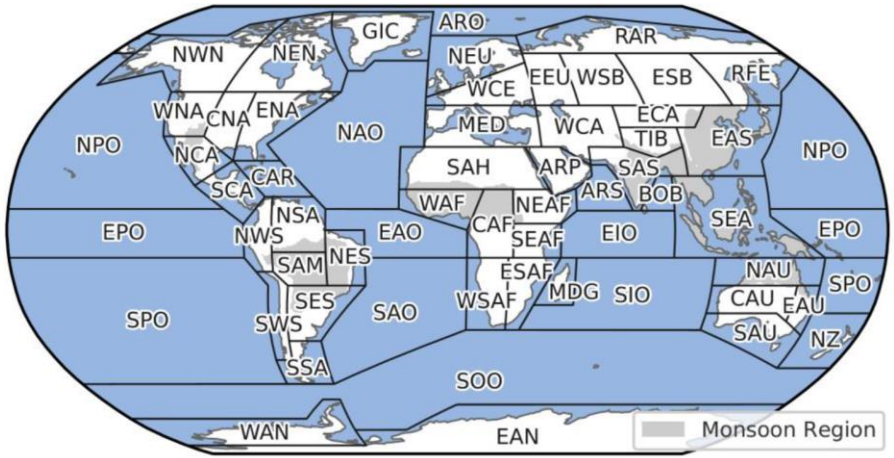
(b) Updated IPCC WGI reference regions (v4)

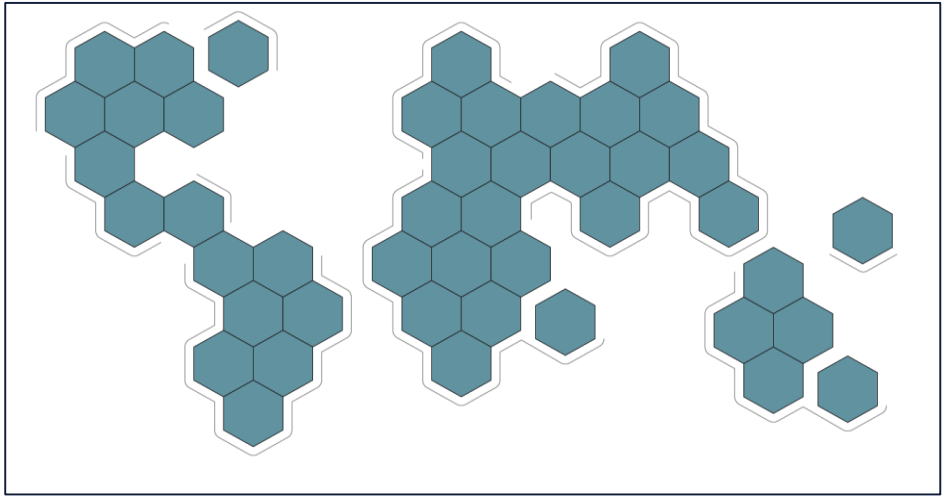


Iturbide et al. (2020)

45 new land regions

(and their representation as hexagons)





Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

Figure SPM.3

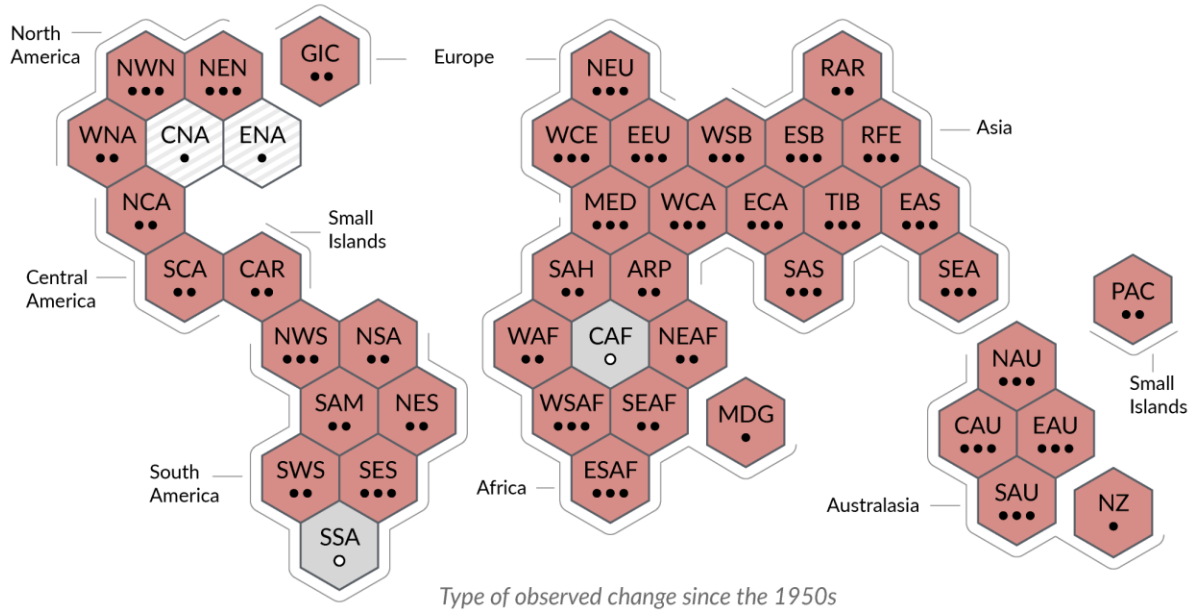
a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in hot extremes

- Increase (41)
- Decrease (0)
- Low agreement in the type of change (2)
- Limited data and/or literature (2)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Type of observed change since the 1950s

Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

Figure SPM.3

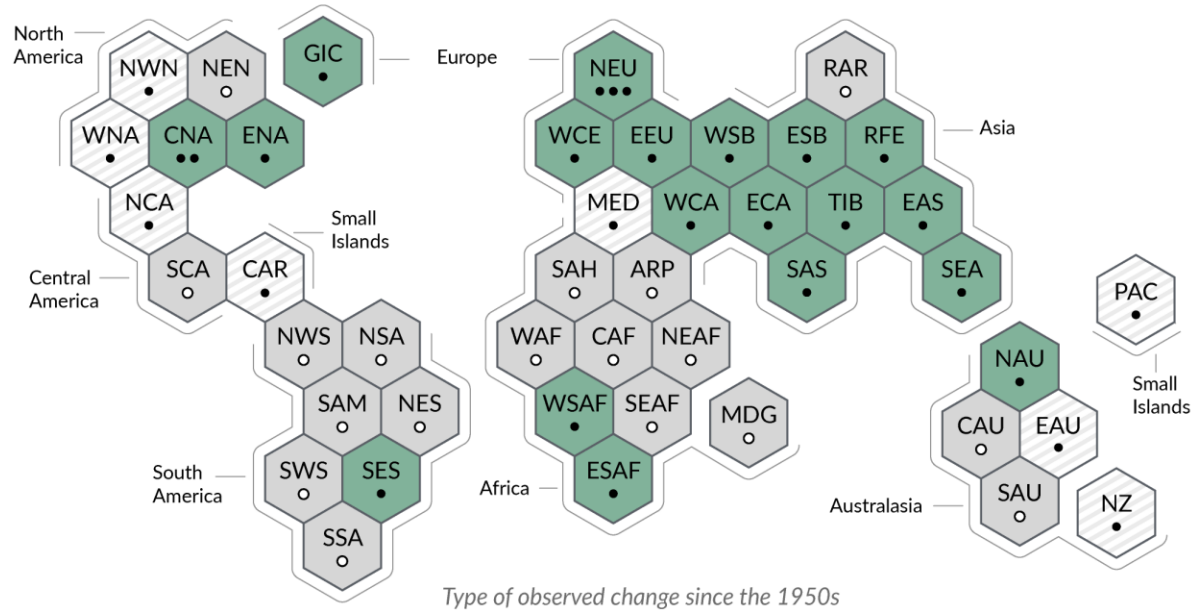
b) Synthesis of assessment of observed change in **heavy precipitation** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in heavy precipitation

- Increase (19)
- Decrease (0)
- Low agreement in the type of change (8)
- Limited data and/or literature (18)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Type of observed change since the 1950s

Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

Figure SPM.3

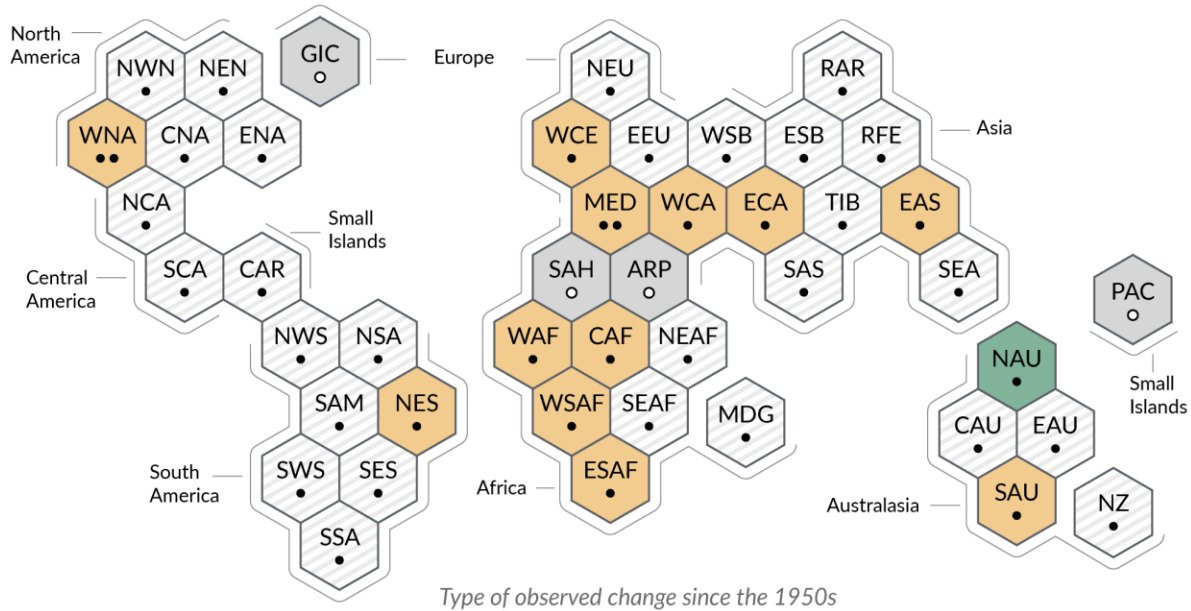
c) Synthesis of assessment of observed change in **agricultural and ecological drought** and confidence in human contribution to the observed changes in the world's regions

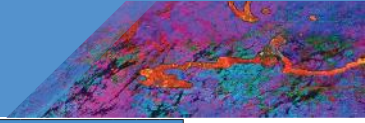
Type of observed change
in agricultural and ecological drought

- Increase (12)
- Decrease (1)
- Low agreement in the type of change (28)
- Limited data and/or literature (4)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence





	Climatic Impact-driver																														
	Heat and Cold				Wet and Dry									Wind				Snow and Ice						Coastal and Oceanic					Other		
	Mean air temperature	Extreme heat	Cold spell	Frost	Mean precipitation	River flood	Heavy precipitation and pluvial flood	Landslide	Aridity	Hydrological drought	Agricultural and ecological drought	Fire weather	Mean wind speed	Severe wind storm	Tropical cyclone	Sand and dust storm	Snow, glacier and ice sheet	Permafrost	Lake, river and sea ice	Heavy snowfall and ice storm	Hail	Snow avalanche	Relative sea level	Coastal flood	Coastal erosion	Marine heatwave	Ocean and lake acidity	Air pollution weather	Atmospheric CO_2 at surface	Radiation at surface
Central and South America																															
Southern Central America	↗	↗ **	↘ **												2								↗		3	↗	↗		↗	
North-Western South America	↗	↗ ***	↘ ***																				↗		3,4	↗	↗		↗	
Northern South America	↗	↗ **	↘ **												2								↗		3,4	↗	↗		↗	
South American Monsoon	↗	↗ **	↘ **			↗ 1																							↗	
North-Eastern South America	↗	↗ **	↘ **		↘						↗												↗		3,4	↗	↗		↗	
South-Western South America	↗	↗ **	↘ **	↗					↗														↗		3	↗	↗		↗	
South-Eastern South America	↗	↗ ***	↘ ***	↗	↗		↗			↘													↗		3	↗	↗		↗	
Southern South America	↗			↗																			↗		3	↗	↗		↗	

Note: There are several region-specific qualifiers/exceptions attached to some of the directions of change/confidence levels indicated above. {12.4}

Key for observational trend evidence ↗ Past upward trend (*medium* or *higher confidence*) ↘ Past downward trend (*medium or higher confidence*)

Key for attribution evidence *** *High confidence* (or more) ** *Medium confidence*

Key for level of confidence in future changes *High confidence* of increase (or more); *Medium confidence* of increase (or more); *Low confidence* in direction of change; *Medium confidence* of decrease; *High confidence* of decrease; Not broadly relevant

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3.3 – 3.6 billion people live in hotspots of high vulnerability to climate change.

[Denis Onyodi / KRCS CC BY-NC 2.0]

Impacts are magnified in cities where more than half the world's population lives.

[Peter Nguyen / Unsplash]

Future global climate risks

Heat stress

Exposure to heat waves will continue to increase with additional warming.

Water scarcity

At 2°C, regions relying on snowmelt could experience 20% decline in water availability for agriculture after 2050.

Food security

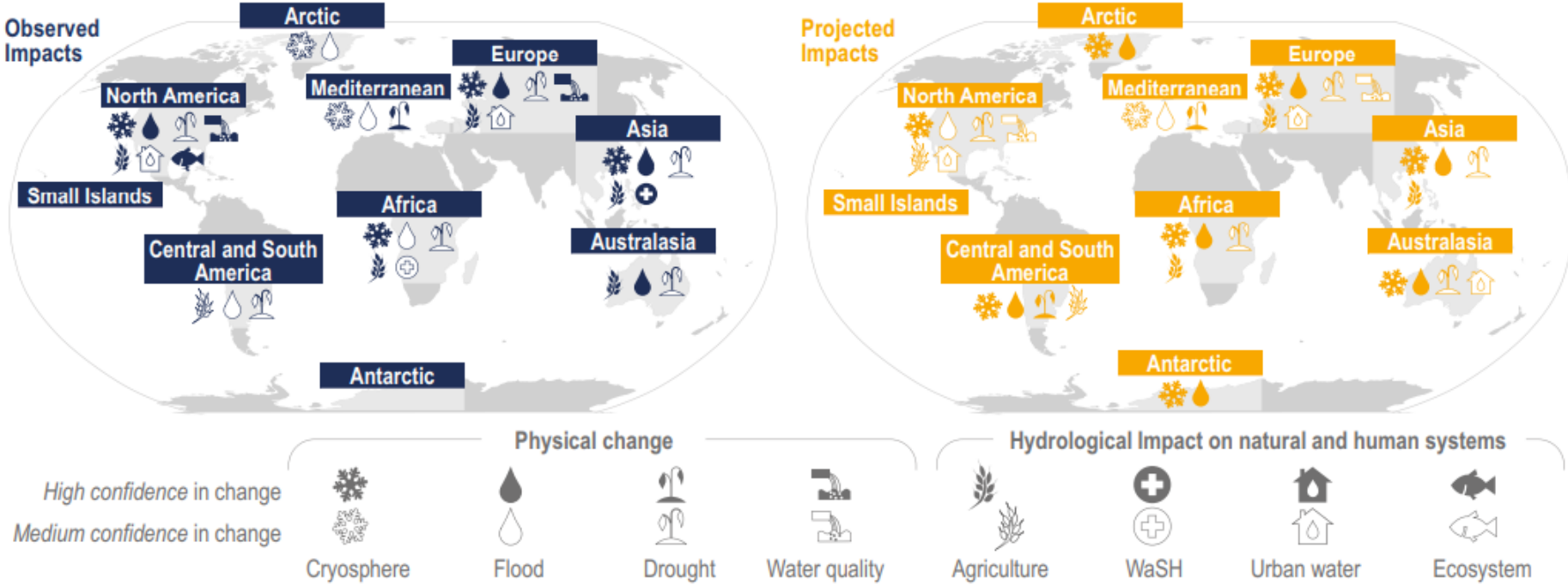
Climate change will increasingly undermine food security.

Flood risk

About a billion people in low-lying cities by the sea and on Small Islands at risk from sea level rise by mid-century.

Observed and future regional water-related risks

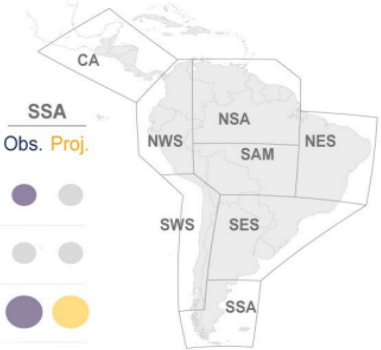
(b) Physical changes, impacts on ecosystems, and impacts on human systems



Synthesis of observed and projected impacts to main sectors in Central and South America

Projections averaged across scenarios and 21st century

	CA		NWS		NSA		SAM		NES		SES		SWS		SSA	
	Obs.	Proj.	Obs.	Proj.	Obs.	Proj.	Obs.	Proj.	Obs.	Proj.	Obs.	Proj.	Obs.	Proj.	Obs.	Proj.
Terrestrial and freshwater ecosystems and their services																
Ocean and coastal ecosystems							na	na								
Water																
Food, fibre and other ecosystem products																/
Cities and infrastructure												/		/	/	/
Health						/						/		/	/	/
Populations in poverty and their livelihoods					/	/	/	/				/	/	/	/	/
Migration, conflict and indigenous knowledge and local knowledge					/	/	/	/				/	/	/	/	/



- Central America (CA)
- Northwest South America (NWS)
- Northern South America (NSA)
- South America Monsoon (SAM)
- Northeast South America (NES)
- Southwest South America (SWS)
- Southeast South America (SES)
- Southern South America (SSA)

Impact level Low ○ Medium ◯ High ◯

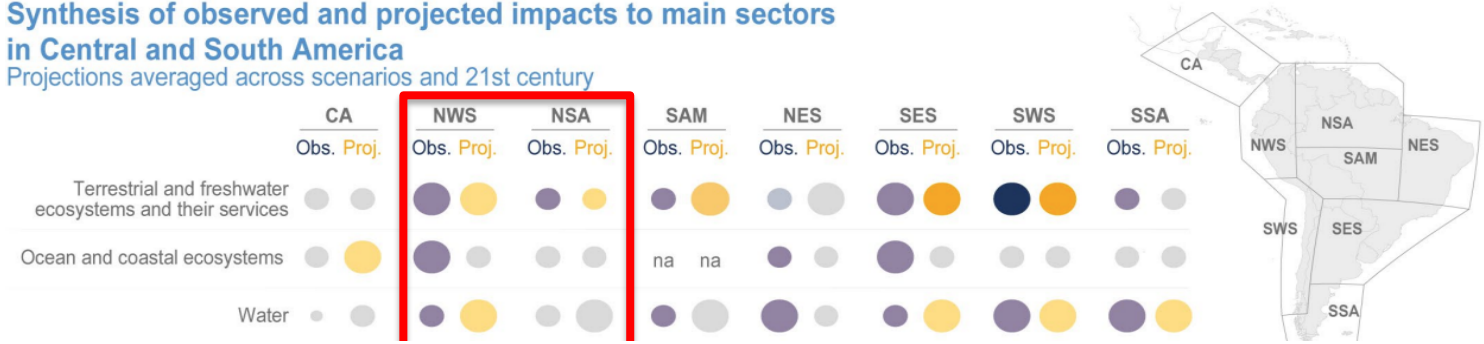
/ = not assessed na = not applicable

Confidence level: Observed impacts

Confidence level: Projected impacts

Low Medium High

Figure 1: Synthesis of observed and projected impacts, distinguished for different sectors and each subregion of Central and South America. Observed impacts refer to a time-period of the last several decades. Projected impacts represent a synthesis across several emission and warming scenarios, indicative of a time-period from mid- to end of the 21st century. {Figure 12.10}



Vulnerability and climate change impacts

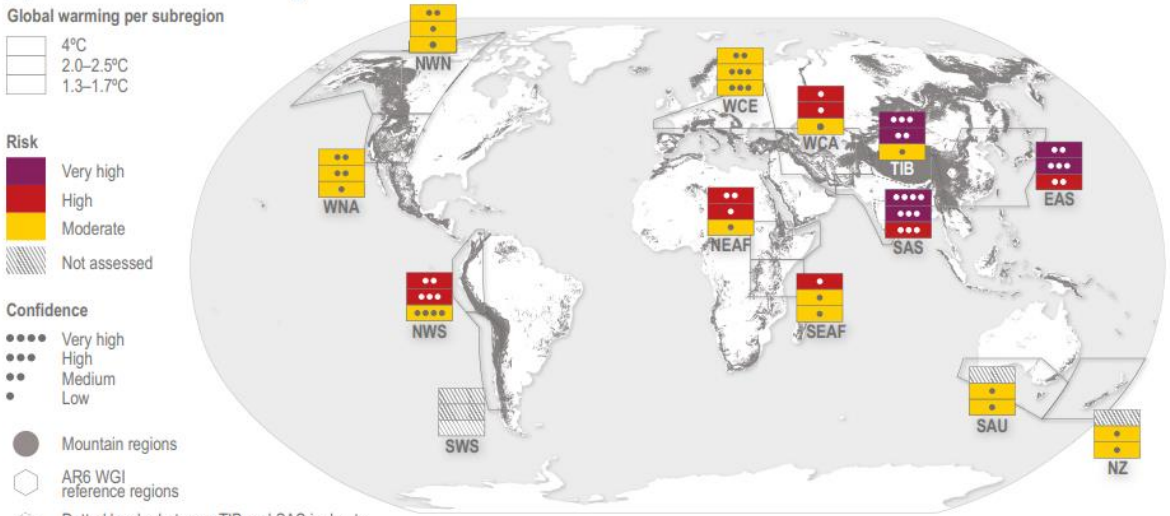
Central and South America are highly exposed, vulnerable and strongly impacted by climate change, a situation amplified by inequality, poverty, population growth and high population density, land use change particularly deforestation with the consequent biodiversity loss, soil degradation, and high dependence of national and local economies on natural resources for production of commodities (*high confidence)*. {ES-Ch12} Many extreme events are already impacting the region and projected to intensify including warming temperatures and dryness, sea level rise, coastal erosion, ocean and lake acidification resulting in coral bleaching, and increasing frequency and severity of droughts in some regions, with associated decrease in water supply, that impact agricultural production, traditional fishing, food security and human health *(high confidence).* {12.8}

Figure 1: Synthesis of observed and projected impacts, distinguished for different sectors and each subregion of Central and South America. Observed impacts refer to a time-period of the last several decades. Projected impacts represent a synthesis across several emission and warming scenarios, indicative of a time-period from mid- to end of the 21st century. {Figure 12.10}

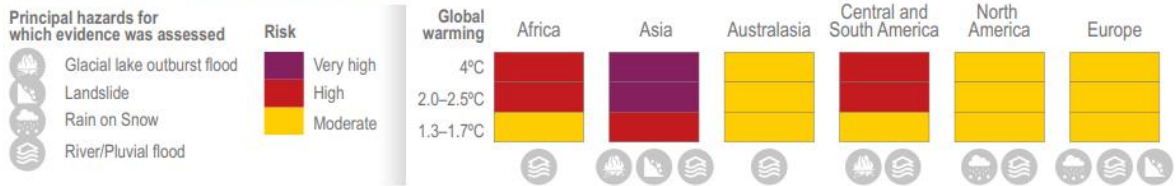
People and infrastructure in mountain regions at risks of landslides and/or floods

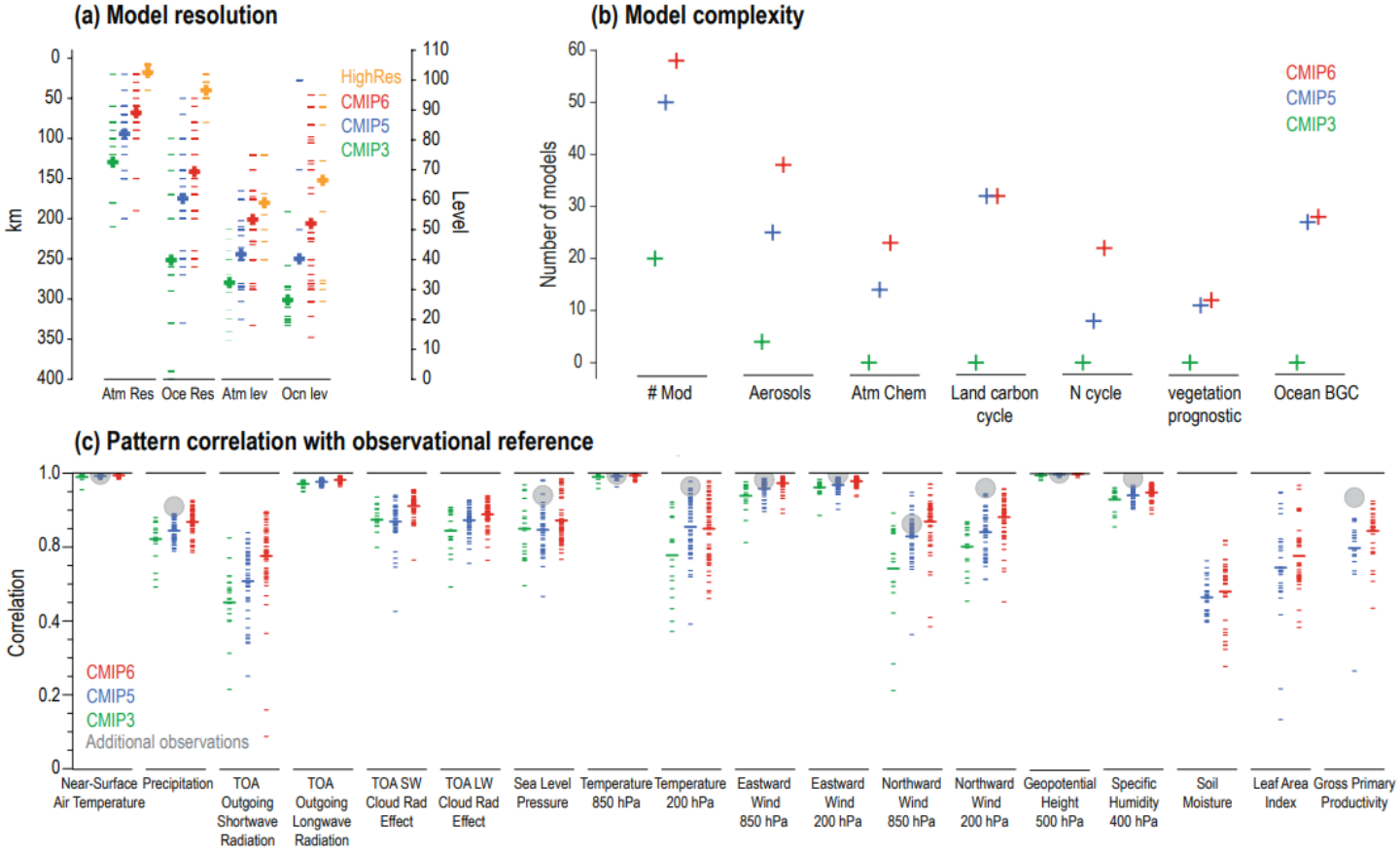
for 1.3–1.7°C, 2.0–2.5°C and 4°C Global Warming Levels

(a) Risks in AR6 WGI reference regions



(b) Risk and driving hazards in mountain regions




(a) Model resolution
km
Level
HighRes
CMIP6
CMIP5
CMIP3
Atm Res
Oce Res
Atm lev
Ocn lev
(b) Model complexity
Number of models
CMIP6
CMIP5
CMIP3
Mod
Aerosols
Atm Chem
Land carbon cycle
N cycle
vegetation prognostic
Ocean BGC
(c) Pattern correlation with observational reference
Correlation
CMIP6
CMIP5
CMIP3
Additional observations
Near-Surface Air Temperature
Precipitation
TOA Outgoing Shortwave Radiation
TOA Outgoing Longwave Radiation
TOA SW Cloud Rad Effect
TOA LW Cloud Rad Effect
Sea Level Pressure
Temperature 850 hPa
Temperature 200 hPa
Eastward Wind 850 hPa
Eastward Wind 200 hPa
Northward Wind 850 hPa
Northward Wind 200 hPa
Geopotential Height 500 hPa
Specific Humidity 400 hPa
Soil Moisture
Leaf Area Index
Gross Primary Productivity

CMIP6 models still have deficiencies in simulating precipitation patterns, particularly in the tropical ocean. Increasing horizontal resolution in global climate models improves the representation of small-scale features and the statistics of daily precipitation (*high confidence*). There is *high confidence* that high-resolution global, regional and hydrological models provide a better representation of land surfaces, including topography, vegetation and land-use change, which can improve the accuracy of simulations of regional changes in the terrestrial water cycle. {3.3.2, 8.5.1, 10.3.3, 11.2.3}

There is *high confidence* that climate models can reproduce the recent observed mean state and overall warming of temperature extremes globally and in most regions, although the magnitude of the trends may differ. There is *high confidence* in the ability of models to capture the large-scale spatial distribution of precipitation extremes over land. The overall performance of CMIP6 models in simulating the intensity and frequency of extreme precipitation is similar to that of CMIP5 models (*high confidence*). {Cross-Chapter Box 3.2, 11.3.3, 11.4.3}

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Thank you!

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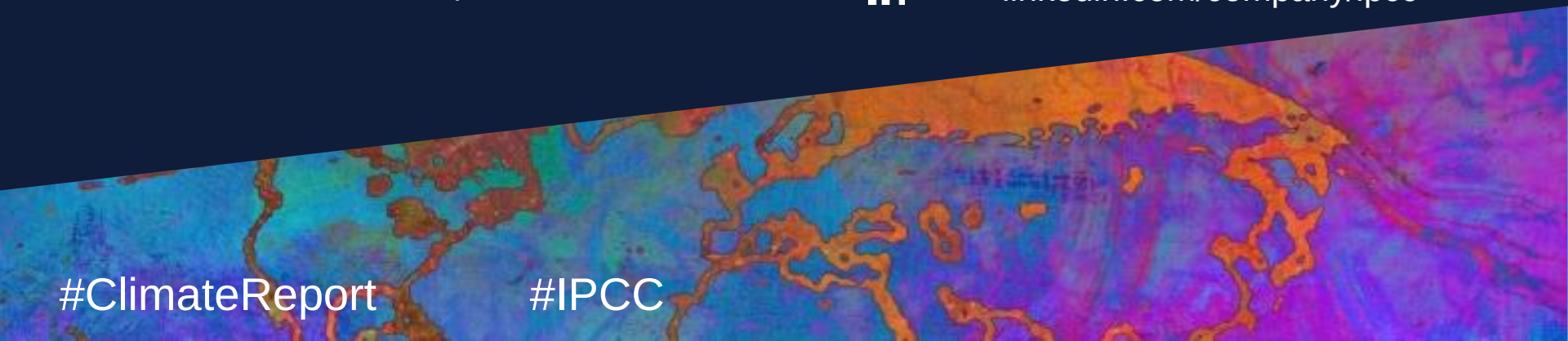

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