ICTP Workshop on Climate Information for Risk Assessment and Regional Adaptation from Global Scale Climate Projections to Local Scale Climate Hazards
Trieste, Italy – June 5th, 2021

National Aeronautic and Space Administration
Goddard Institute for Space Studies

IPCC AR6 WGI Provides Actionable Climate Information

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- AR6 WGI goes more firmly connects the dots between human actions and observed changes in average and extreme climate conditions
- New emphasis on regional climate changes and actionable climate information
  - More regional, more targeted to nature and society, clear confidence levels
- WGI provides a useful starting point for mitigation, adaptation and risk planning

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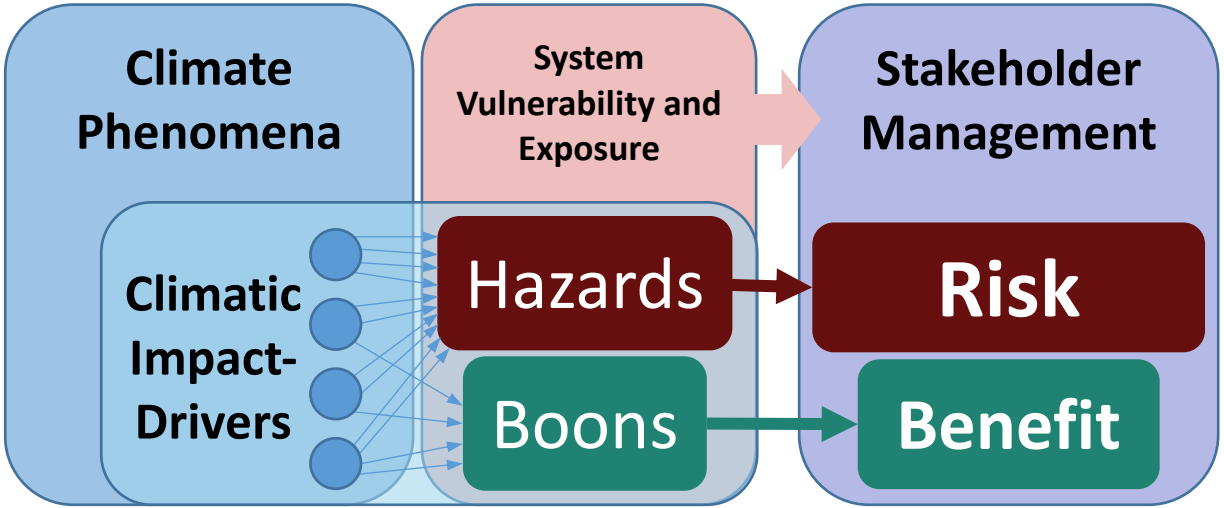
Delivering climate information right up to the point of risk assessment

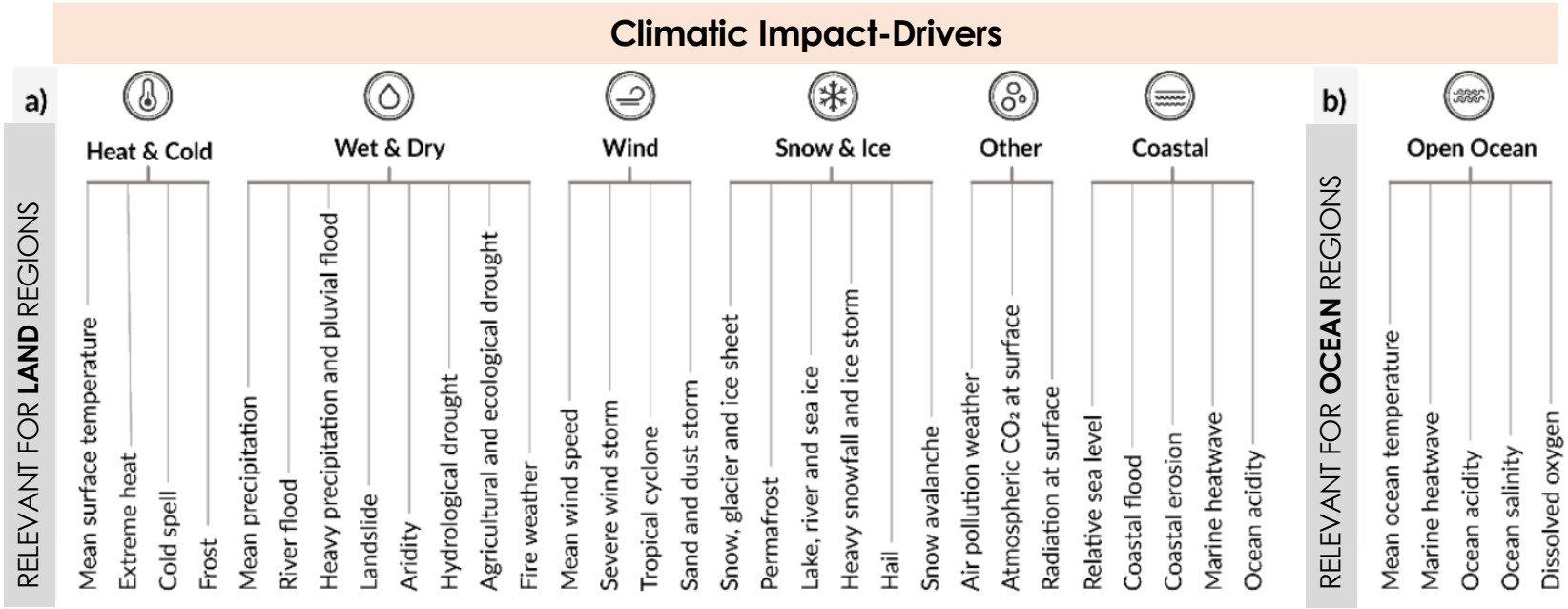
A climatic impact-driver (CID) is a climate condition that directly affects elements of society or ecosystems. Climatic impact-drivers and their changes can lead to positive, negative, or inconsequential outcomes (or a mixture).



CID Framework Paper -- Ruane et al., 2022

Look for Relevant Responses Across Many Climate Factors

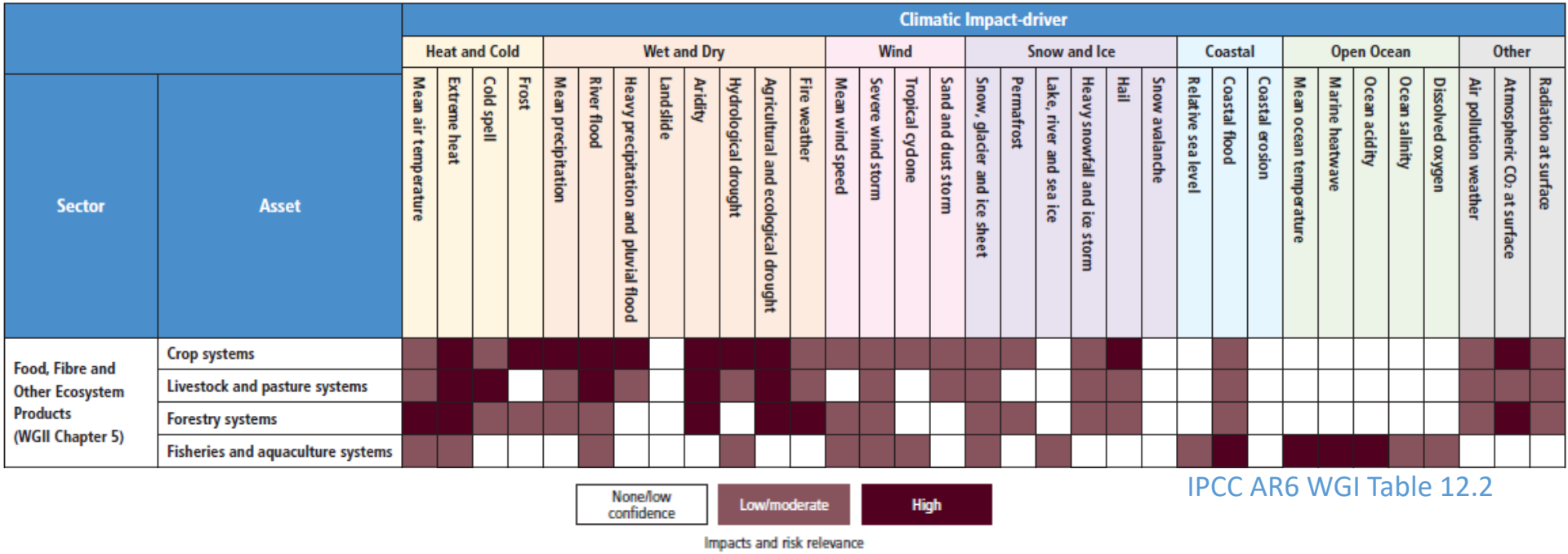
A **climatic impact-driver (CID)** is a climate condition that directly affects elements of society or ecosystems. Climatic impact-drivers and their changes can lead to positive, negative, or inconsequential outcomes (or a mixture).



Adopted from IPCC WGI (2021)
Figure SPM.9; see also WGI Chapter 12
Ranasinghe et al. (2021)

Climate Information Connected to Sectors

For each important aspect of climate change

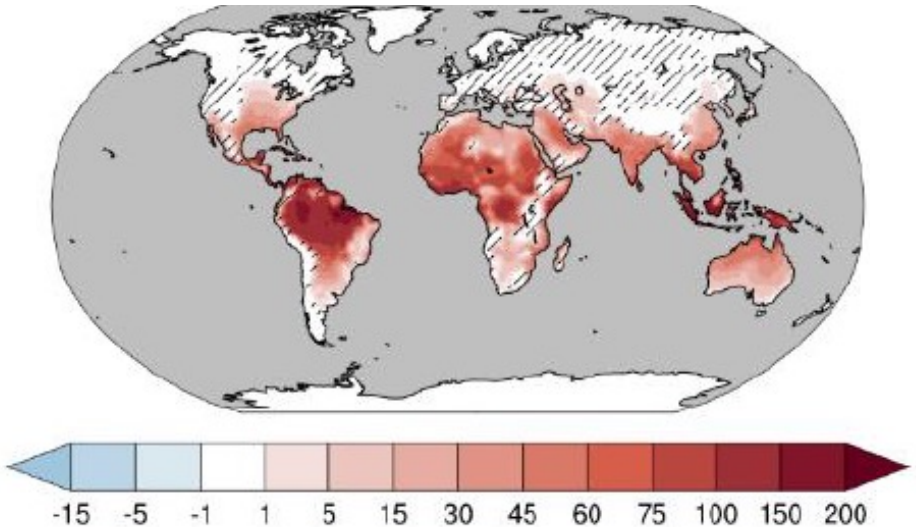


IPCC AR6 WGI Table 12.2

Terrestrial and Marine Ecosystems
Water Resources // Cities // Health
Poverty/Livelihoods (*includes agricultural land)**

Each climate factor can affect multiple sectors
Each sector is affected by multiple climate changes

Outdoor heat tolerance thresholds more frequently exceeded



Change in the Number of days per year where the NOAA Heat Index indicates "dangerous" conditions

Mid-century under a high emissions pathway

- Each category of climate information can be further elaborated with useful indices and metrics
- Changes in intensity, frequency, duration, seasonal timing and spatial extent are foundation for resilience planning

Figure 12.4

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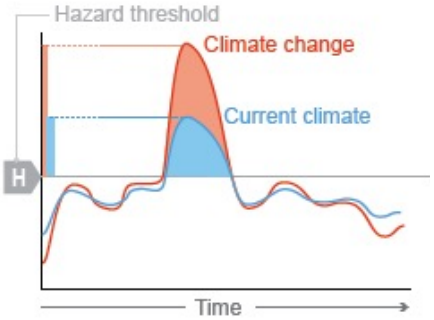
Metrics help us analyze how systems respond to different aspects of climate conditions

Intensity and Magnitude



Climate change can alter the **intensity and magnitude**, **frequency**, **duration**, **timing** and **spatial extent** of a region's climate hazards

Challenge:
- Determining the context-specific response thresholds, suitability bounds and operational ranges for human and natural systems

Adopted from IPCC WGI (2021)
FAQ 12.3; see also WGI Chapter 12
Ranasinghe et al. (2021)

Applications benefit from creation of CID Metrics tied to biophysical or engineered responses

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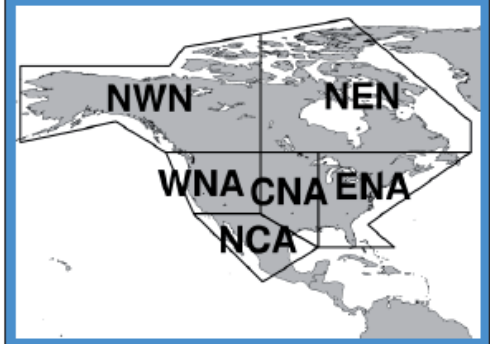
Wet and dry	Mean precipitation	Mean precipitation and its diurnal and seasonal cycles.	Total monsoon-season rainfall *(Water resources)*
	River flood	Episodic high water levels in streams and rivers driven by basin runoff and the expected seasonal cycle of flooding	1-in-100 years flood discharge *(Infrastructure)*
	Heavy precipitation and pluvial flood	Episodic high rates of precipitation and resulting localized flooding of streams and flat lands	99th percentile daily precipitation total *(Cities)*
	Landslide	Ground and atmospheric conditions that lead to geological mass movements, including landslide, mudslide and rockfall	Frequency of slope failure *(Transportation)*
	Aridity	Mean conditions of precipitation and evapotranspiration compared to potential atmospheric and surface water demand, resulting in low mean surface water, low soil moisture and/or low relative humidity	Water table depth (Water resources)
	Hydrological drought	Episodic combination of runoff deficit and evaporative demand that affects surface water or groundwater availability.	1-in-100 years low streamflow levels *(Ecosystems)*
	Agricultural and ecological drought	Episodic combination of soil moisture supply deficit and atmospheric demand requirements that challenge the vegetation's ability to meet its water needs for transpiration and growth. *Note: "agricultural" versus "ecological" term depends on affected biome*	Ratio of actual/potential evapotranspiration *(Agriculture)*
	Fire weather	Weather conditions conducive to triggering and sustaining wildfires, usually based on a set of indicators and combinations of indicators including temperature, soil moisture, humidity and wind. Fire weather does not include the presence or absence of fuel load. *Note: distinct from wildfire occurrence and area burned*	Forest Fire Danger Index *(forestry)*

IPCC AR6 WGI Table 12.1 and Ruane et al., 2022

Examine



Region	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 acidity	Air pollution weather	Atmospheric CO_2 at surface	Radiation at surface
North Central America (NCA)	●	●	●																				●		2		●		●	
Western North America (WNA)	●	●	●		3		5	5	4,7		6,7	6,7		8		6	●		●	1		1	●	5	2		●		●	
Central North America (CNA)	●	●	●						7		7	7		8		4			●				●		2		●		●	
Eastern North America (ENA)	●	●	●		5							7		8			● 1		●	1		1	●		2		●		●	
North-Eastern North America (NEN)	●	●	●		● 5				5		6,7	6,7		8			● 1,6	●	●			1	4	4,6	2,6		●		●	
North-Western North America (NWN)	●	●	●		● 5			6	5		6,7	6,7		8			● 1	●	●			1,6	● 9		2		●		●	

High confidence of decrease | Medium confidence of decrease | Low confidence in direction of change | Medium confidence of increase | High confidence of increase | Not broadly relevant

IPCC AR6 WGI Table 12.8

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CID Framework Encourages us to Connect Climate Information to System Responses

Bottom line:

- To produce relevant climate information for impacts and for risk assessment, we need to identify the types of climate conditions that drive responses in the things we care about.
- These are contextual and cannot be universally declared 'hazards'
- Need to work closely with stakeholders and expert partners to determine metrics and thresholds
- Need to close gaps and recognize strengths and weaknesses in systems climate risk understanding