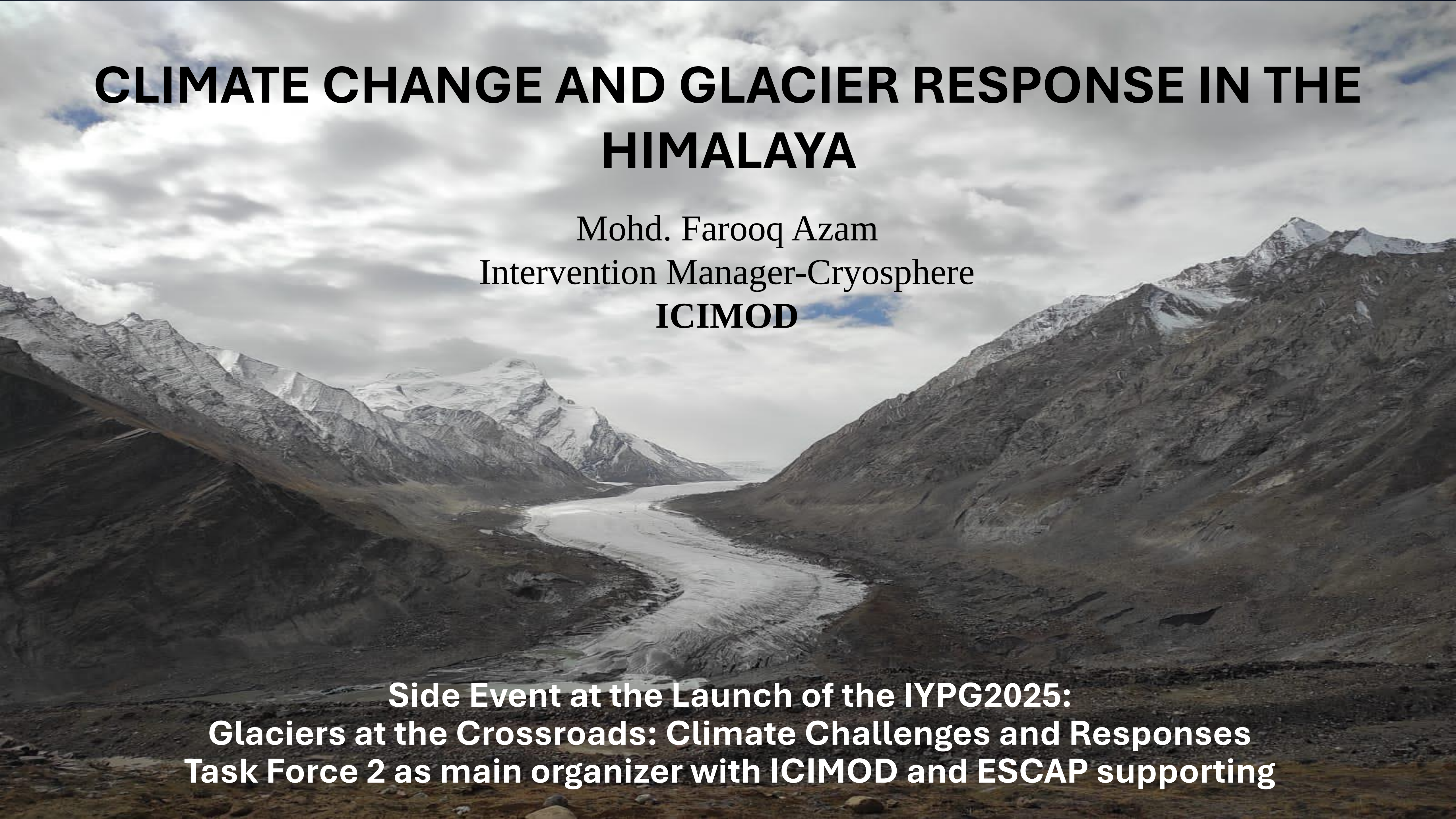

CLIMATE CHANGE AND GLACIER RESPONSE IN THE HIMALAYA

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Intervention Manager-Cryosphere
ICIMOD

Side Event at the Launch of the IYPG2025:
Glaciers at the Crossroads: Climate Challenges and Responses
Task Force 2 as main organizer with ICIMOD and ESCAP supporting

OVERVIEW OF HIMALAYAN CRYOSPHERE

- SNOW
- GLACIERS
- PERMAROST

OVERVIEW OF HIMALAYAN CRYOSPHERE

Features	Indus	Ganges	Brahmaputra	HKH (km2)
Basin area* (km^2)	1,120,000	1,087,300	543,400	2,750,700
Glacierized area (km^2)	24,698	8,314	9,513	42,525*[1]
Number of glaciers	21,524	6,616	11,520	39,660
Ice volume (km^3)	2,327	473	622	3,422
Average Snow cover Area	15.1 %	4.8 %	20.3 %	1.5 million (HKH)*[2]
Permafrost Area	-	-	-	16 times of glacier area*[3]

*1: Azam et al. 2021; *2: Kulkarni et al. 2021; *3: Gruber et al., 2012, 2017

OVERVIEW OF HIMALAYAN CRYOSPHERE

1 Billion population

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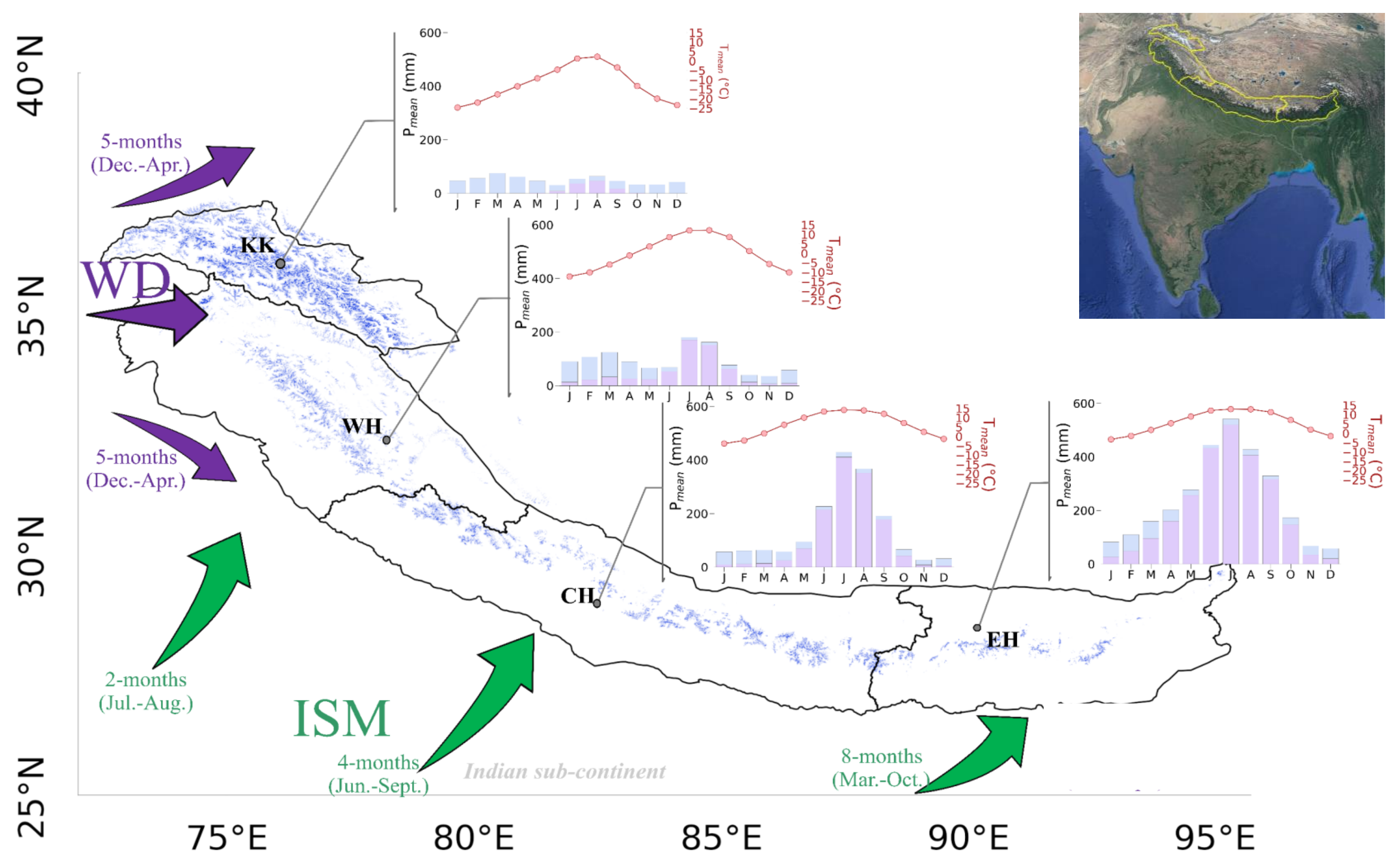
600,000 km^2

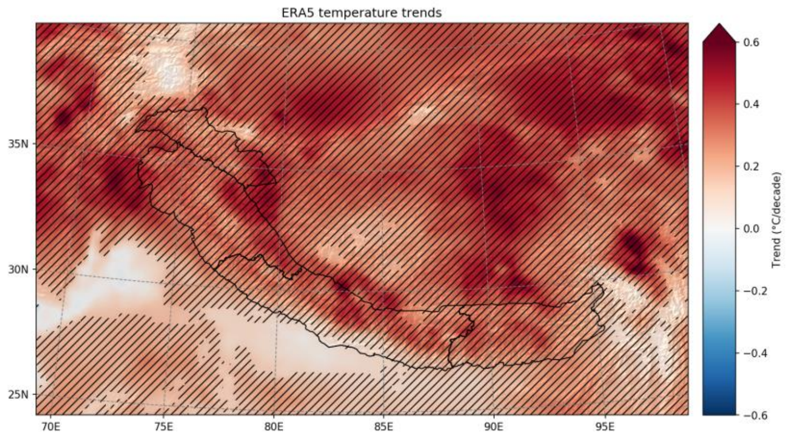
25,000 MW

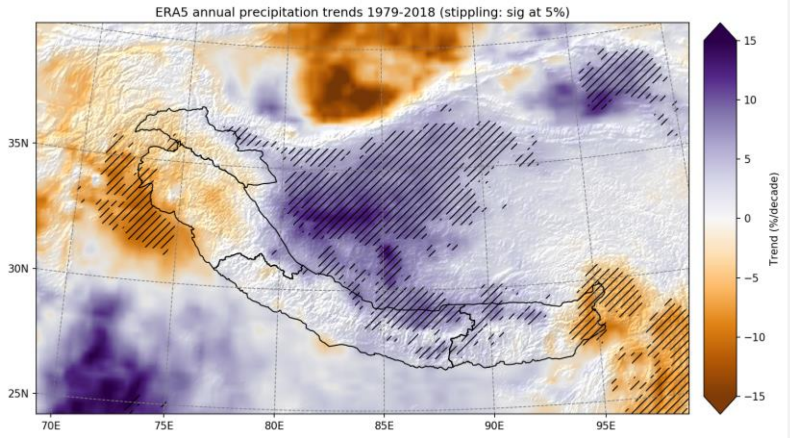
*1: Azam et al. 2021; *2: Kulkarni et al. 2021; *3: Gruber et al., 2012, 2017

CLIMATE OF THE HIMALAYA



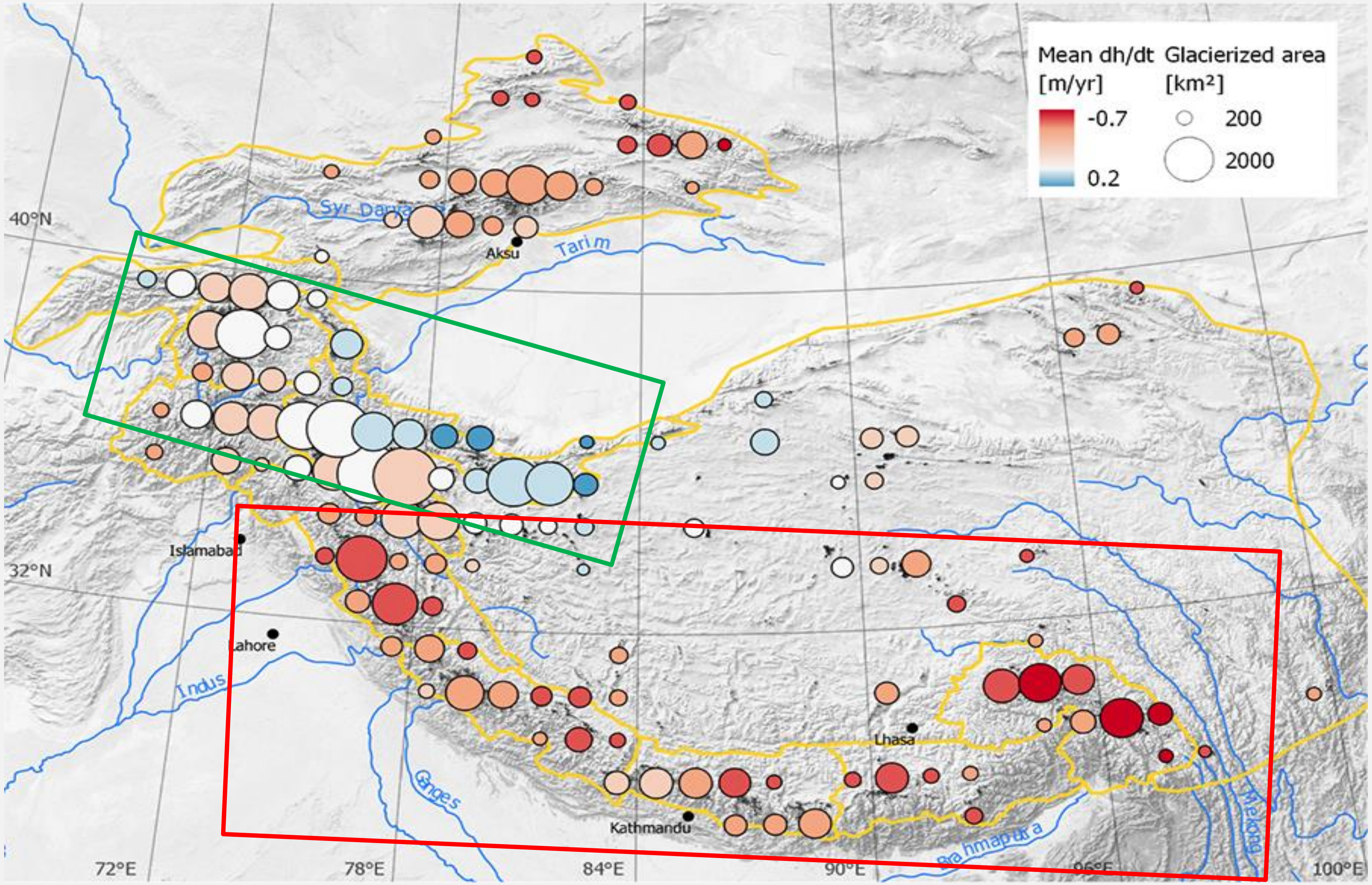
Temperature and Precipitation Trends





Source: Azam et al., 2021

GLACIER MASS WASTAGE: GEODETIC METHOD

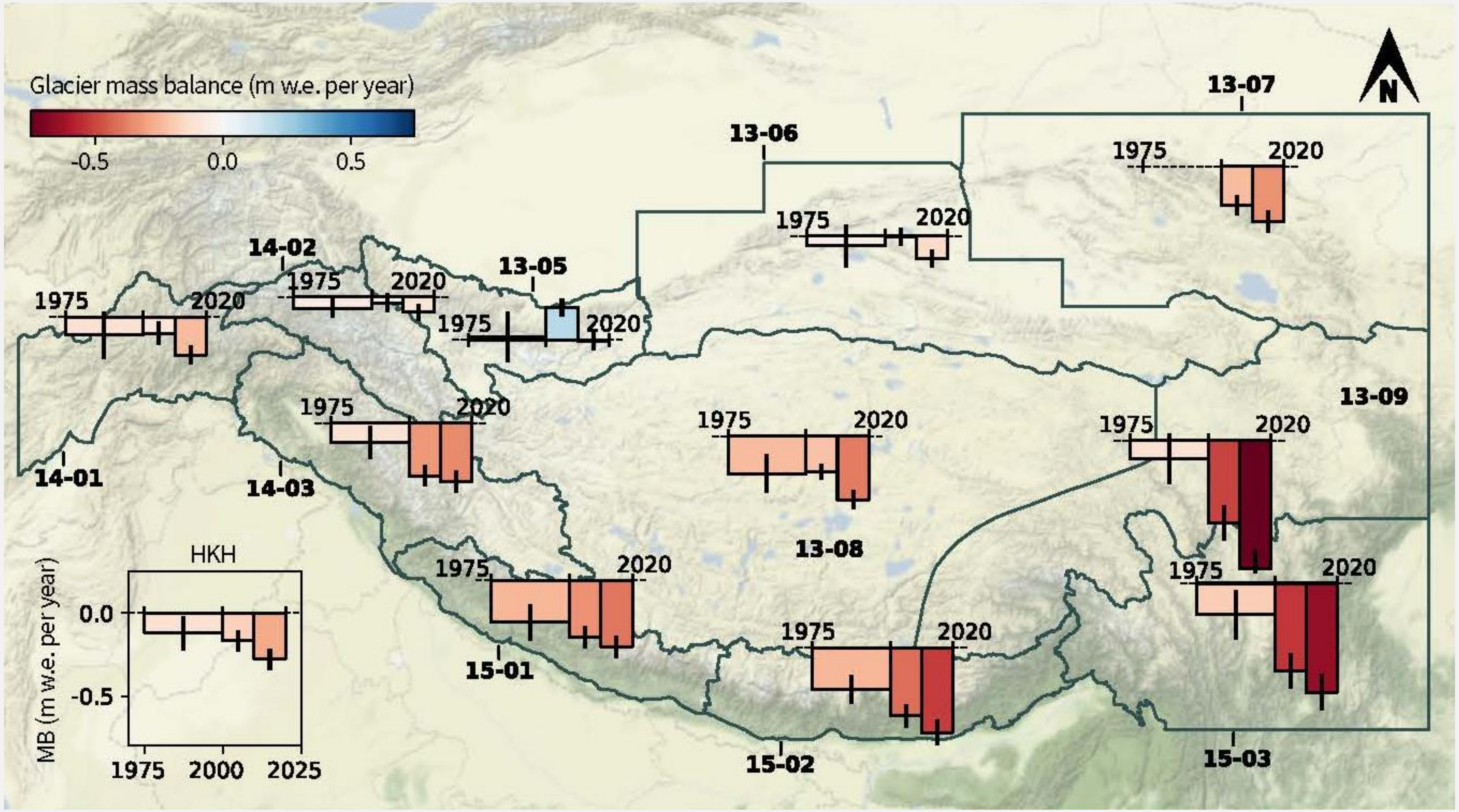


Himalaya:
Continuous wastage since 1970s
Heterogenous glacier wastage

Karakoram Anomaly:
Balanced mass balances since 1970s
End of Karakoram Anomaly = 2015…

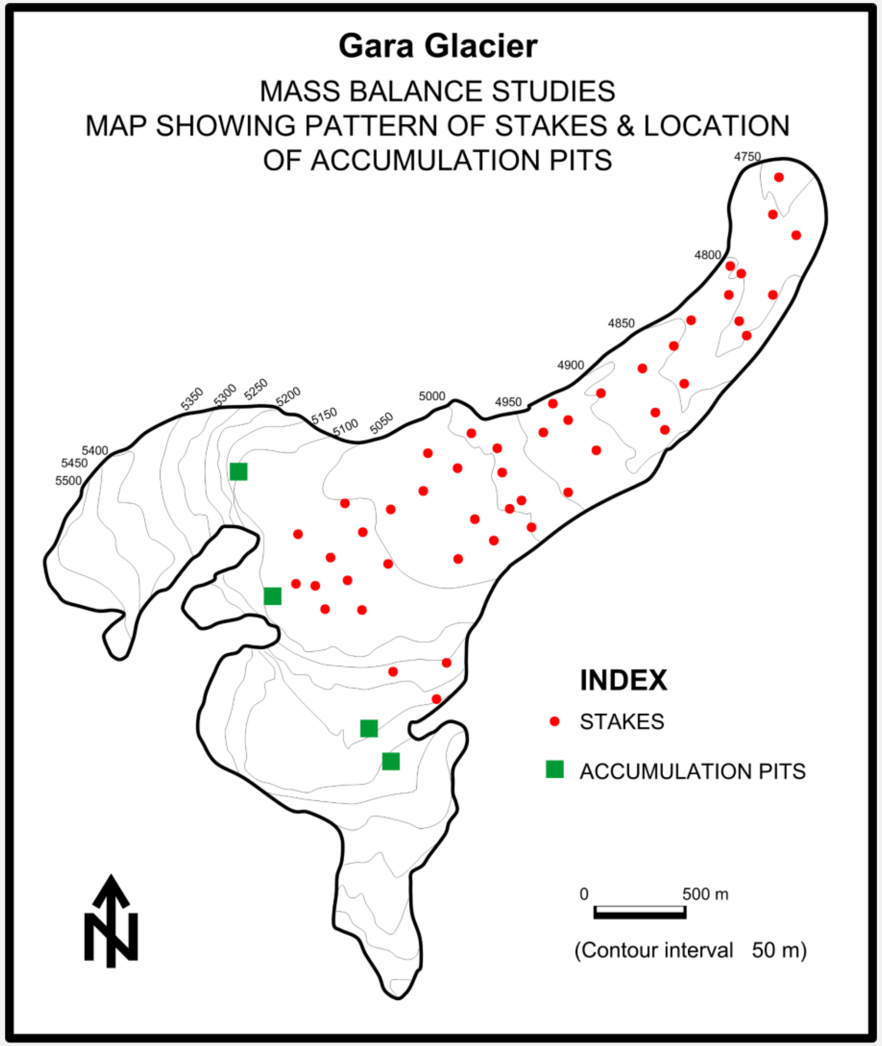
Source: Brun et al., 2017

GLACIER MASS WASTAGE: GEODETIC METHOD



Accelerated wastage of Glaciers post-2000 (HiWISE)

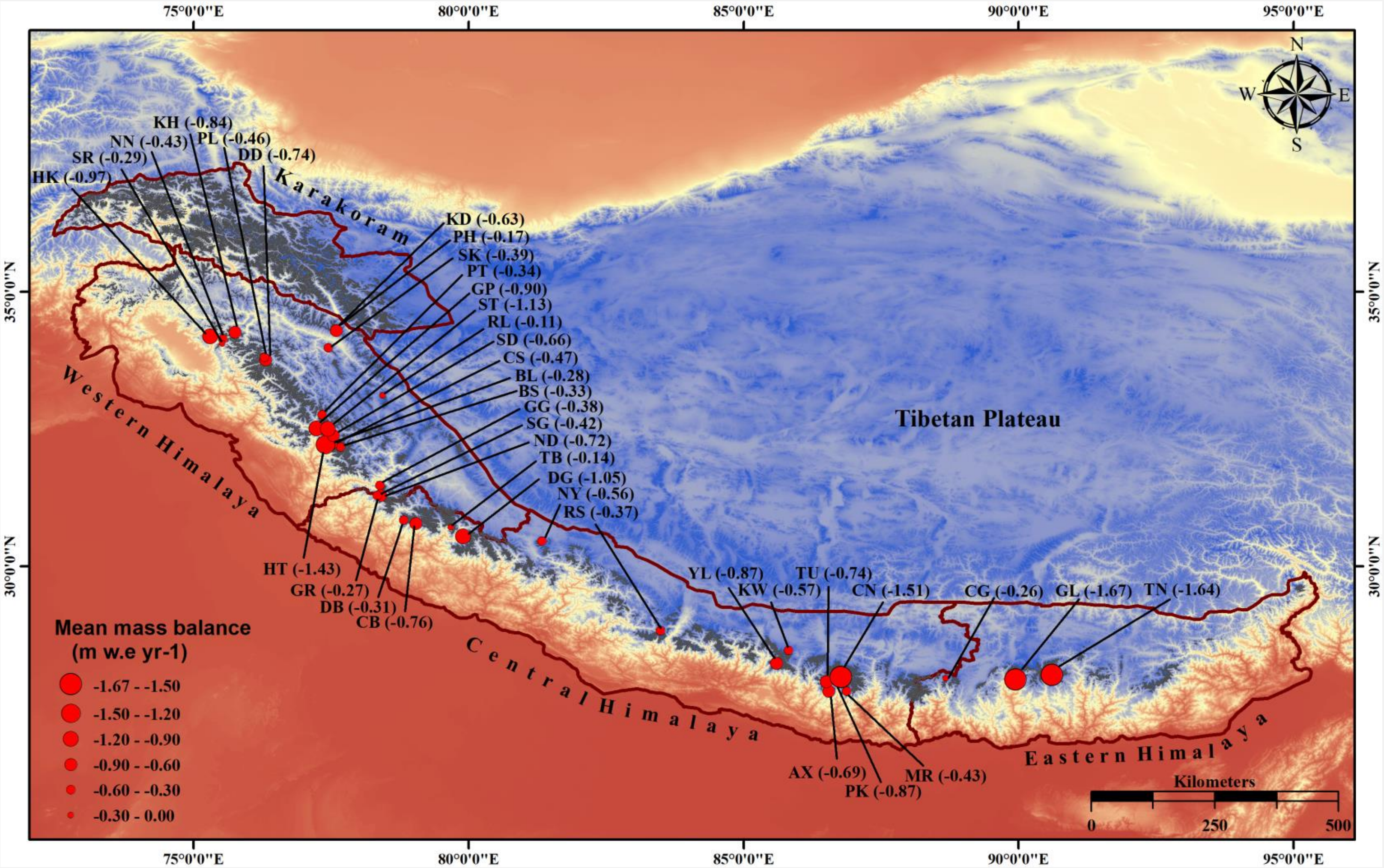
GLACIER MASS WASTAGE: IN-SITU METHOD



The first glacier mass balance observation was started on Gara Glacier in 1974.

Source: Azam, 2025 (under review)

GLACIER MASS WASTAGE: IN-SITU METHOD

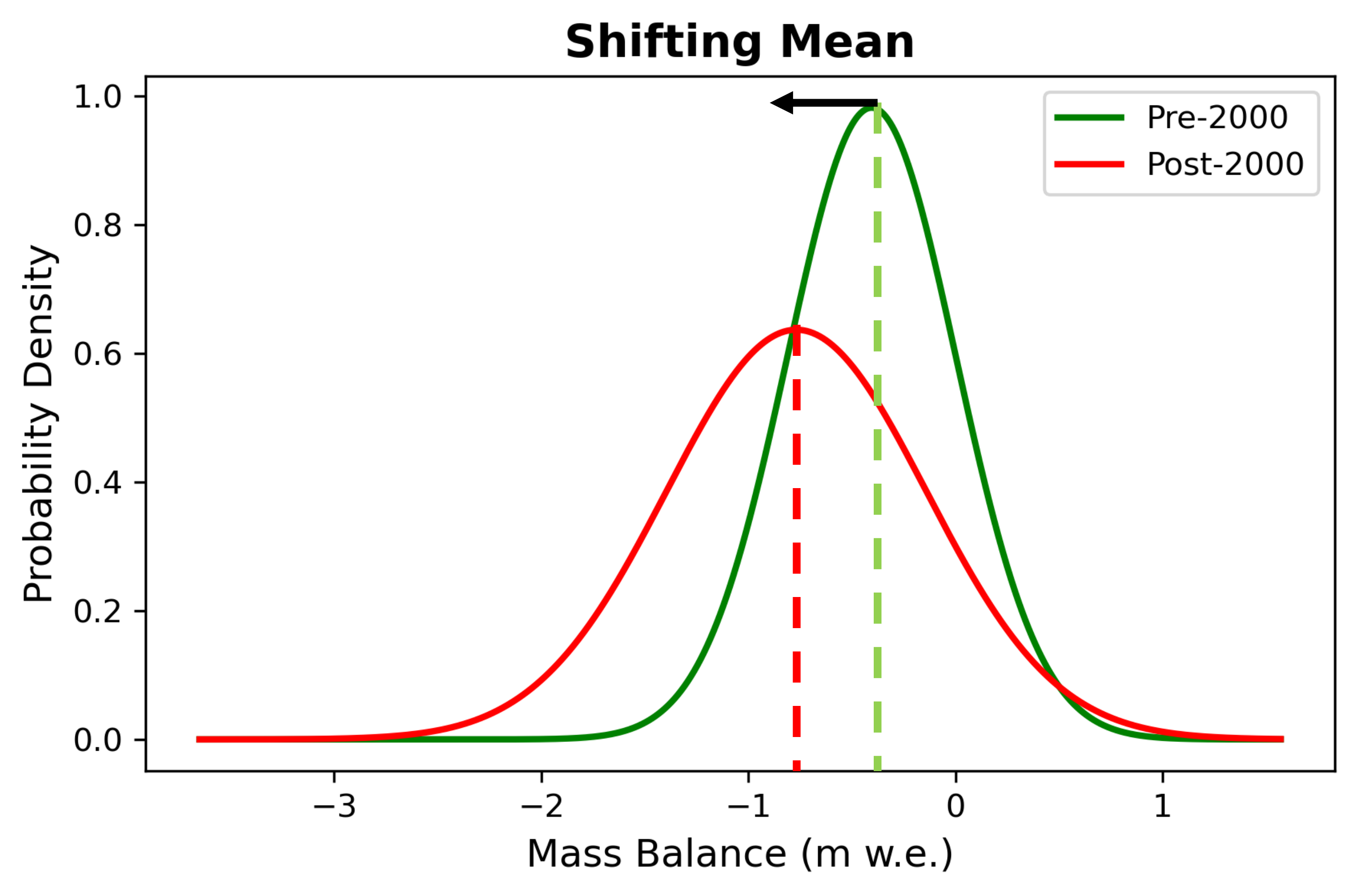


- 38 glaciers have been observed
- Mostly from small glaciers
- Last for 10-15 years only
- No glacier from Karakoram or HK

The mean mass wastage is -0.67 m w.e. a^{-1} over 1975-2023

Source: Azam, 2025 (under review)

GLACIER MASS WASTAGE: IN-SITU METHOD

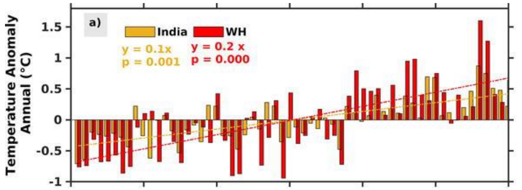


Pre-2000: 75 MB observations; Post-2000: 225 MB observations

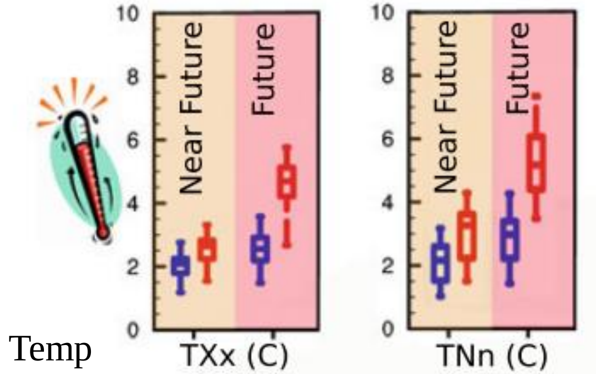
The mean mass wastage almost doubled post-2000 from -0.40 to -0.77 m w.e. a^{-1}.

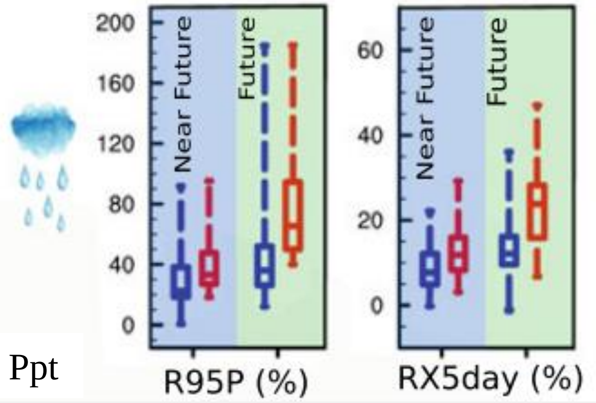
Source: Azam, 2025 (under review)

EXTREMES CLIMATE AND WEATHER EVENTS IN THE HIMALAYAN REGION: *Recent and Projected changes*

Weather and Climate Variables	Phenomena	Impact on Cryosphere	Trends: Recent	Trends: Future Projections	References
Temperature	Extreme heat events	Glacier mass balance; Permafrost thaw, Ice and rock avalanche	• Extreme cold events significantly decreased and extreme warm events significantly increased since 1960s. 	• The frequency and intensity of warm days and warm nights are projected to increase over the Himalaya in the next decades, while that of cold days and cold nights will decrease Extreme warm days and extreme cold nights to become warmer in the future over HKH	Krishnan et al (2019); Sun et al (2017); Bhardwaj et al (2021); Manzoor and Ahanger (2022); Dikisha et al (2022); Nandargi & Dhar, 2011
	Extreme cold events				
Precipitation	Extreme High Precipitation	GLOF, Debris flow, Landslide	• Overall increasing trend in annual intense precipitation amount, days, and intensity over the period 1961–2013 over the HKH	• Enhanced likelihood of occurrence of extreme precipitation over the HKH with regional variation	
	Extreme Low Precipitation	Drought events			
	Extreme snowfall	Snowstorm, Snow Avalanche	• **One-day extreme** rainfall frequency in the Himalaya **increased** from the 1950s.		

TXx: Maximum of daily maximum temperature
TNn: Maximum of daily minimum temperature
R95P: Annual total precipitation when the daily amount exceeds the 95th percentile of wet-day precipitation
RX5day: Maximum consecutive 5-day precipitation





Projected changes in extreme indices over HKH; RCP4.5 (blue colour) and RCP8.5 (red colour)

Source: Sabin et al., 2020

EXPECTED CHANGES IN HIMALAYAN CRYOSPHERE

- In a +1.5° C globe, glaciers in the HKH will lose 2/3rd of their volume by 2100
- Glacier lakes will increase

(Kraaijenbrink et al. 2017)

* Snow-covered areas and snow volumes will decrease, and snowline elevation will rise in most regions

* Permafrost thawing will continue, and active layer thickness will increase

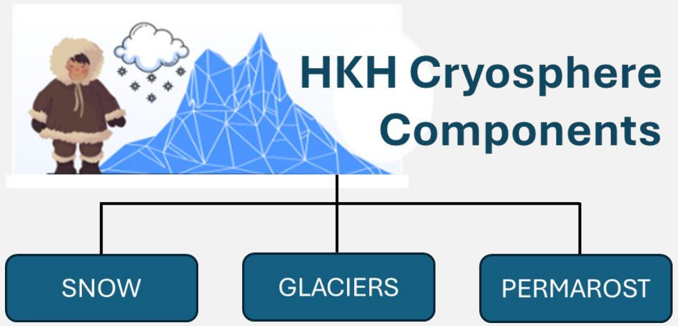
Impacts water requirements of 1 billion people living downstream (Azam et al., 2021)

Influence long-term power generation of small hydropower projects (Rasul and Molden, 2019)

Glacier retreat and permafrost thaw may increase the likelihood of landslides, GLOF events in future (Hock et al., 2019)

SOME KEY MESSAGES

- Capacity building in the HKH region
- Monitoring of new glaciers from unexplored regions
- Large-glacier monitoring
- Installation of high-altitude automatic weather stations: interactions
- Glacier-hazards interactions
- Initiation of Permafrost observations



The International Year of Glaciers' Preservation 2025 marks the start of the Decade of Action for Cryospheric Sciences (2025–2034). Staying focused, committed, and driving positive change over the next decade is essential.