

# Climate Change in the Hindu Kush Himalaya

The Hindu Kush Himalaya (HKH) are home to the largest reserve of snow and ice outside the North and South Poles. In an area sixty-thousand kilometres square, the HKH contains approximately 54,000 glaciers, 6,000 km<sup>3</sup> of ice, and 0.76 million km<sup>2</sup> of snow cover.

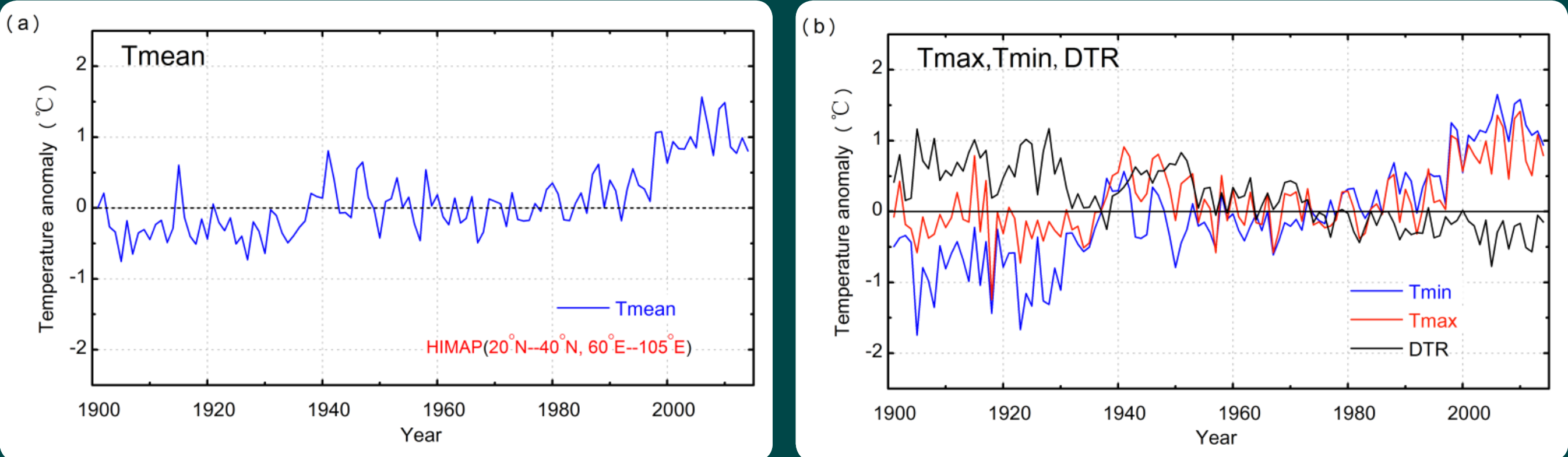
Ten rivers basins begin the HKH and they provide water, food, energy, and ecosystem services to more than 1.3 billion people in South Asia.

## Why Climate of HKH needs better understanding

The HKH are sensitive to climate change and variability. Most of the warming in the 20th century is attributed to human activity and increasing greenhouse gas concentrations. These greenhouse gas concentrations are placing stress on world’s cryosphere, which could trigger a multitude of bio-physical and socio-economic impacts on the region’s ecosystem and communities.

## Past climate change

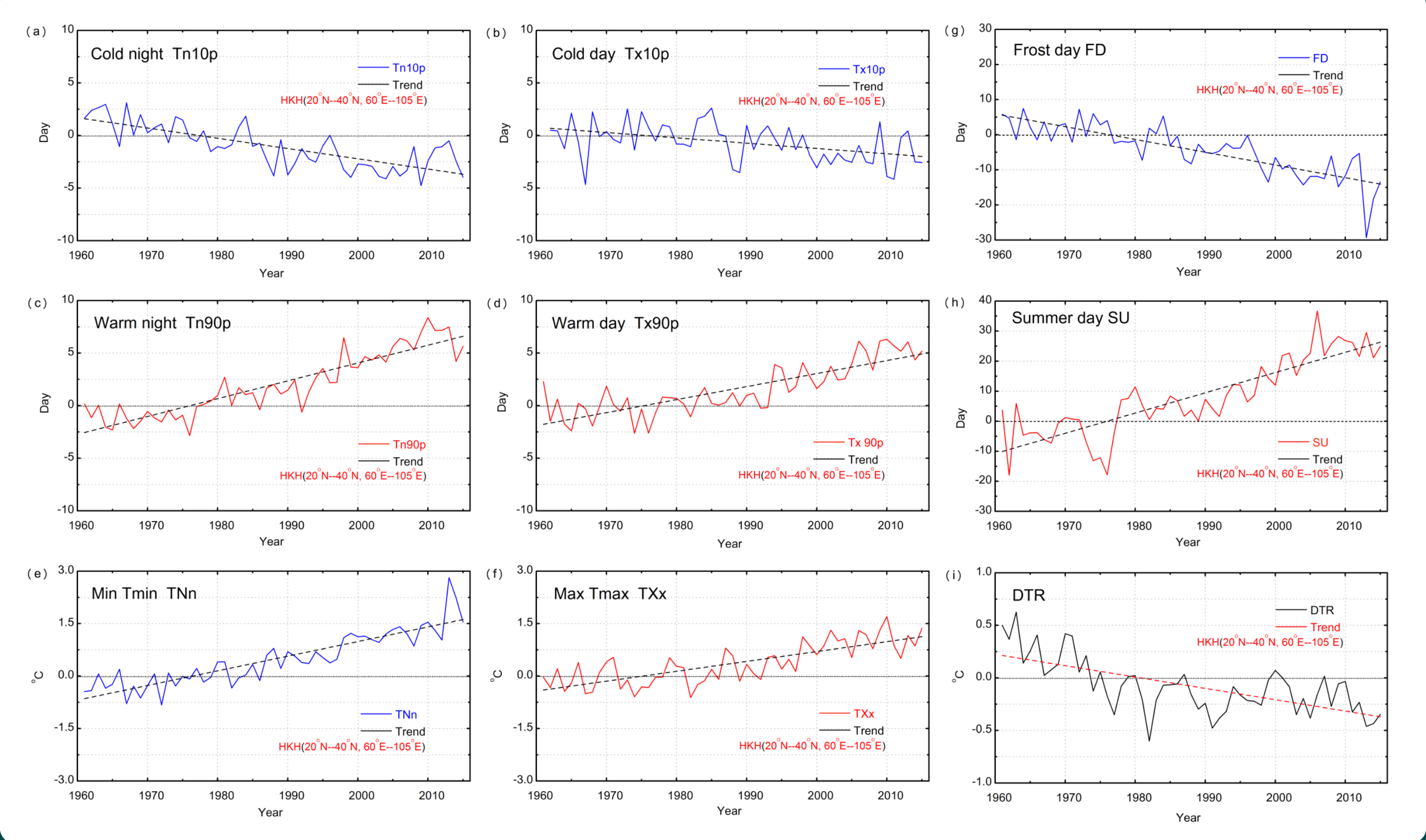
Looking backward, the HKH has seen rapid warming in the past decades equal to or more than global averages.



Region	Data source	Period	Trend (°C/decade)			
			Tmax	Tmin	DTR	Tmean
HKH	CMA	1901-2014	0.077*	0.176*	-0.101*	0.104*
		1951-2014	0.156*	0.278*	-0.123*	0.195*
Globe (Lands+Oceans)	GHCN	1901-2014				0.084*
		1951-2014				0.129*

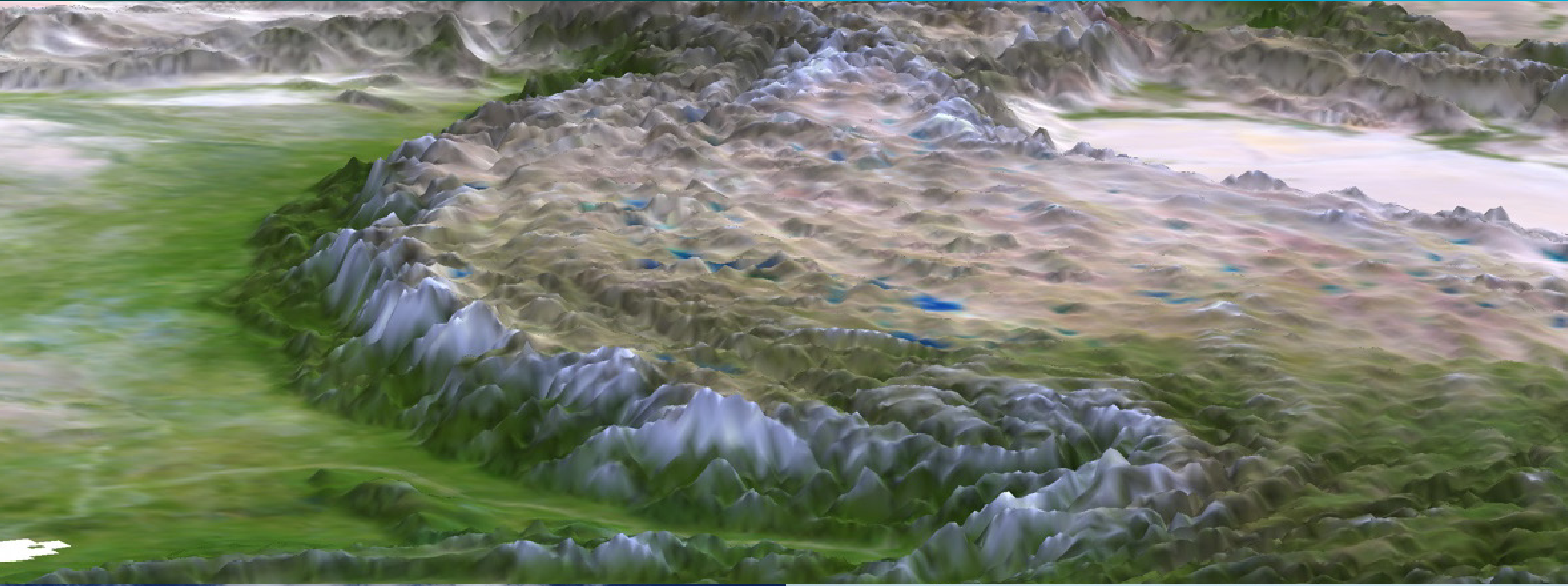
## Extreme changes in temperature

Warm extremes in temperature have increased significantly. The same is true for precipitation extremes.



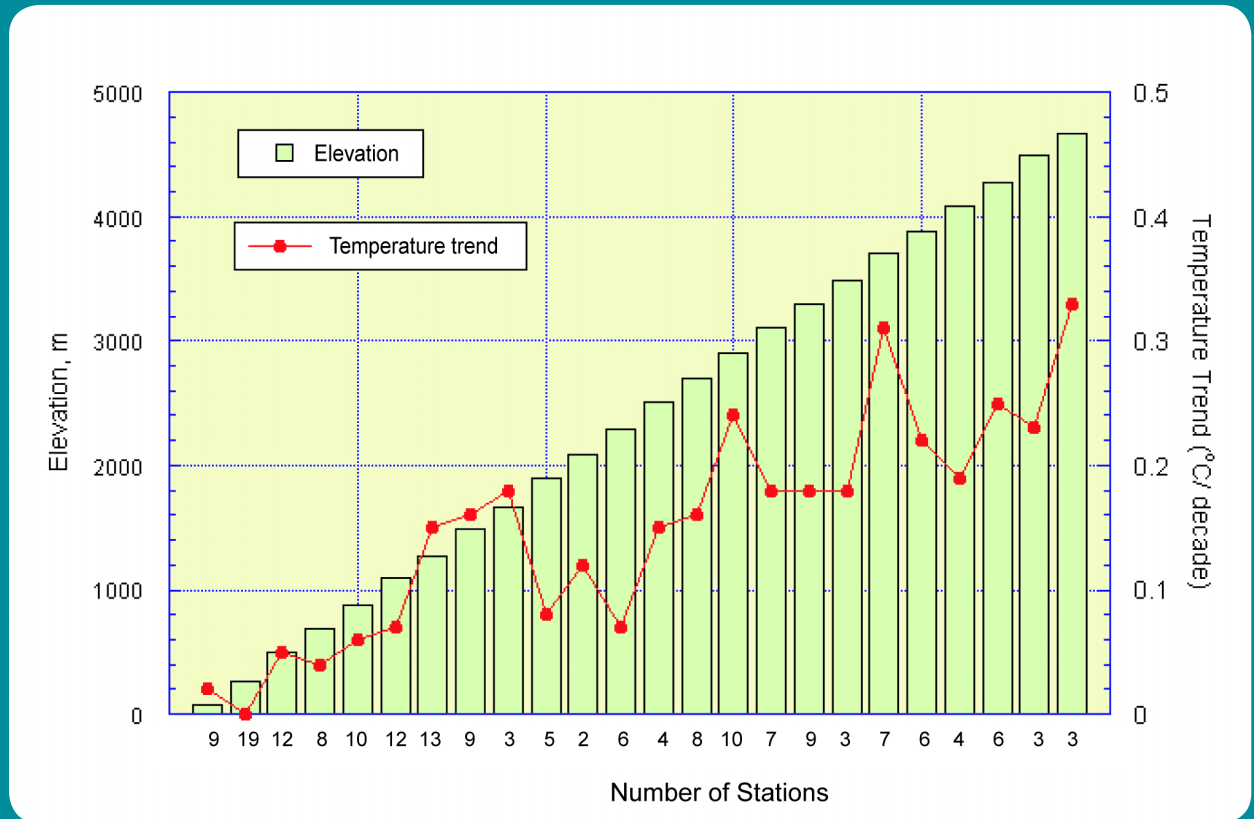
## Conclusion

- There is adequate evidence of temperature increases.
- Both temperature and precipitation extremes are increasing.
- EDW is present in the region.
- Glaciers are unlikely to vanish but will shrink significantly.
- Future water availability will depend on location.
- Changes in water demand will be important.
- Many climate uncertainties remain.

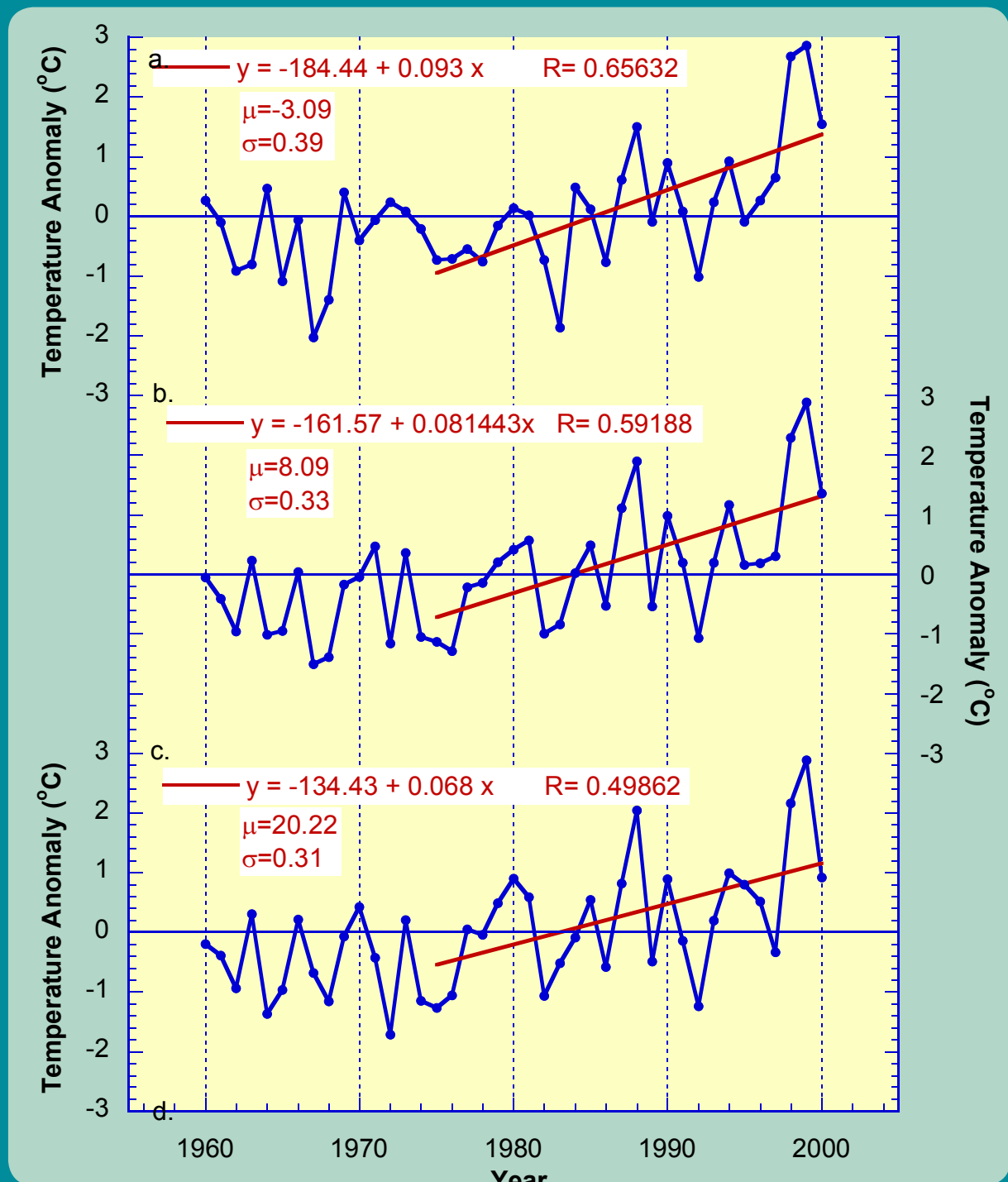


## Elevation dependent warming

The elevation dependent warming (EDW) phenomenon in the HKH, particularly in the Tibetan plateau and surrounding areas, has been widely reported.



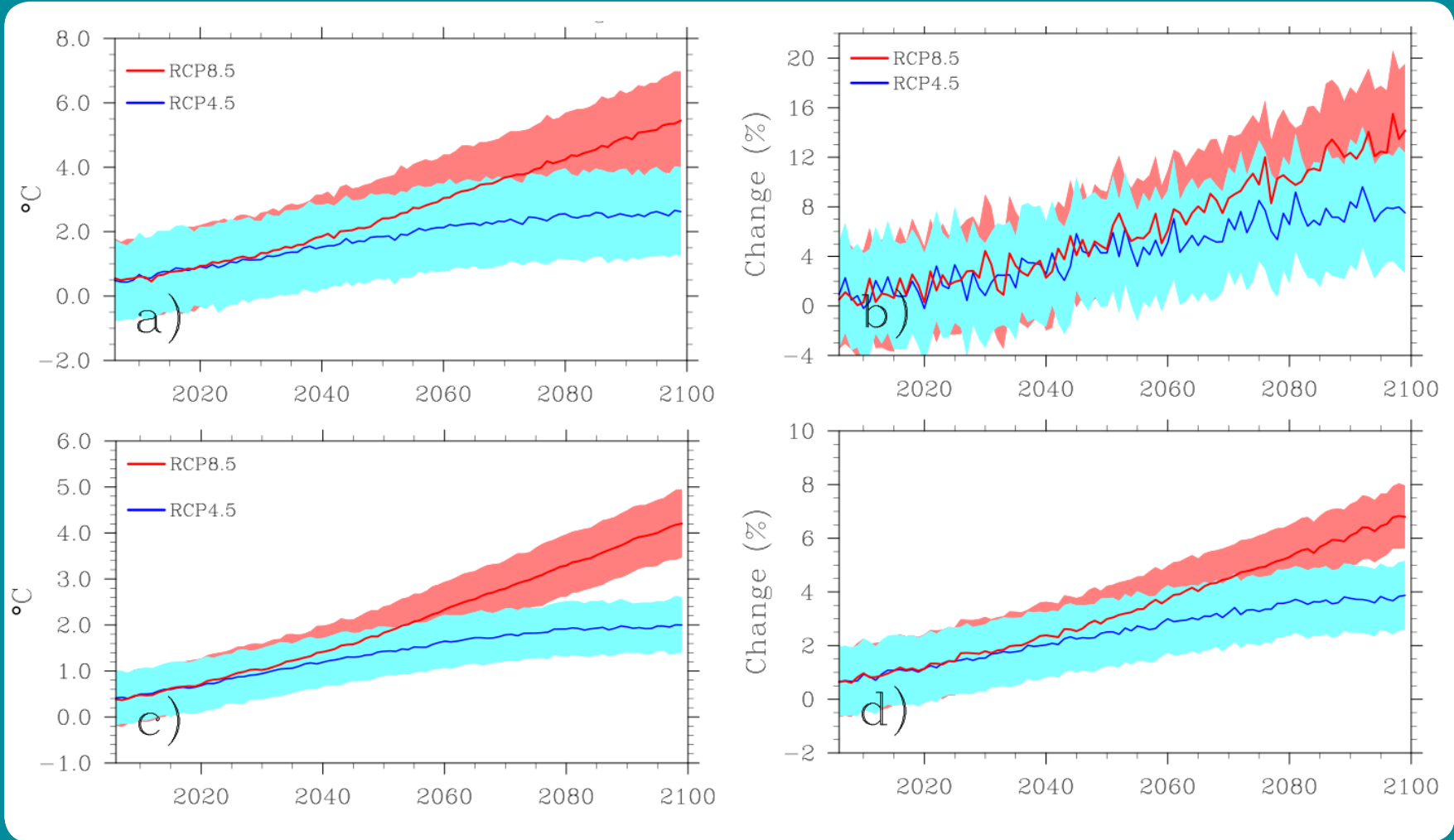
Liu and Chen, 2000



Shrestha et al. 2009

## Climate projection

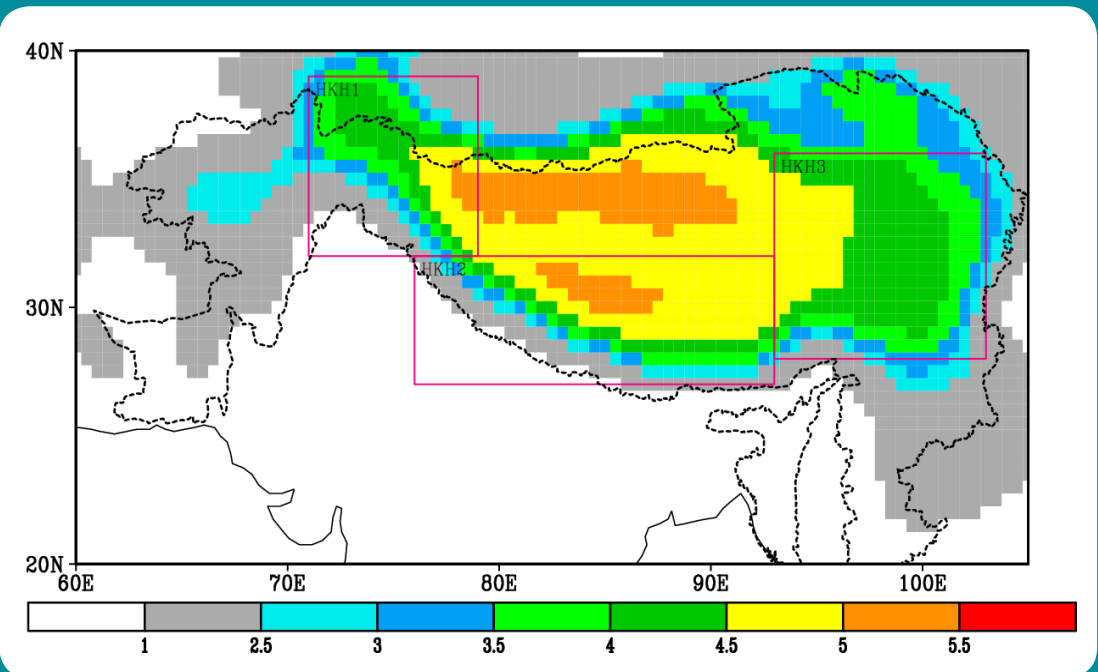
Climate models project further increases in HKH temperatures and precipitation in the 21st century.



Change between 2006-2100 relative to 1976–2005  
RCP4.5 - blue  
RCP8.5 - red  
The 25-model ensemble mean is shown by the solid line  
The projected temperature change in RCP4.5 is 2.5 ± 1.5 by the end of the 21st century relative to the change recorded between 1976–2005 (5.5 ± 1.5 in RCP8.5).

## The HKH in a 1.5 degree world

In the future, even if global warming is kept to 1.5°C, warming in the HKH will likely be 0.3°C, and in the northwestern parts of the region at least 0.7°C higher.



RCP	Model	Global	HKH	HKH1	HKH2	HKH3
RCP2.6	GISS-E2-R_r1i1p3	1.48	1.82	1.87	1.73	2.35
RCP2.6	MIROC5_r1i1p1	1.48	1.95	2.54	2.46	2.28
RCP2.6	NorESM1-ME_r1i1p1	1.44	1.68	2.05	1.85	1.63
RCP2.6	HadGEM2-AO_r1i1p1	1.57	1.47	2.04	1.49	1.50
RCP2.6	MPi-ESM-MR_r1i1p1	1.58	2.16	2.58	2.42	2.11
	MEAN	1.51	1.82	2.22	1.99	1.97
	RANGE	0.14	0.69	0.71	0.97	0.85

## Acknowledgements

The findings reflected in the poster are based on HIMAP Chapter 3

Coordinating Lead Authors: Raghavan Krishnan (IITM, India), Arun B. Shrestha (ICIMOD/Nepal) and Guoyu Ren (CMA/CUG, China)

Lead Authors: Rupak Rajbhandari (TU, Nepal), Sajjad Saeed (KU Leuven, Belgium/Pakistan), Jayanarayan Sanjay (IITM, India), Md. Abu Sayed (BCAS, Bangladesh), Ramesh Vellore (IITM, India), Ying Xu (CMA, China), Qinglong You (NUIE, China), Yuyu Ren (BCC/CMA, China)

Contributing Authors: A.P. Dimri (JNU, India), Arthur Lutz (Future Water, the Netherlands), P. Singh (Nagoya University, Japan/Nepal), X. Sun (CUG, China) and Y. Zhan (CMA, China)

Chapter Coordinator: Arun B. Shrestha (ICIMOD/Nepal)