TRANSECT

Centre for Econics and Ecosystem Management

Hochschule für nachhaltige Entwicklung Eberswalde

GEFÖRDERT VOM Bundesministerium für Bildung und Forschung

Climate change and glaciers in the Karakoram region

Dr. Michael Spies
Eberswalde University for Sustainable Development

Image Source: NASA Blue Marble
Next Generation (Oct 2004);
thematicmapping.org

Meteorological stations in the Hindukush-Karakoram-Himalaya region

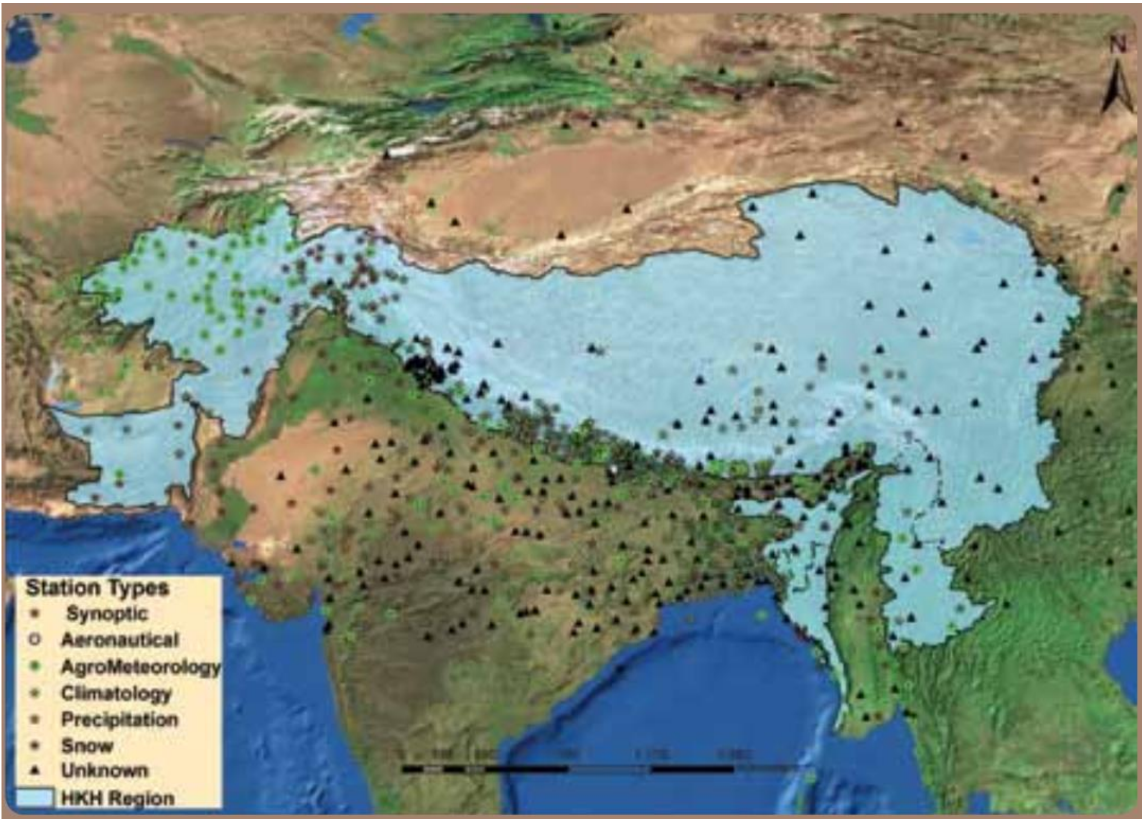
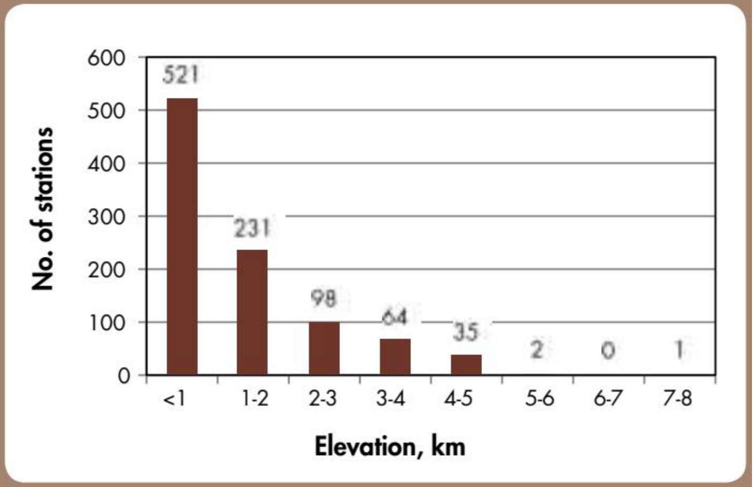


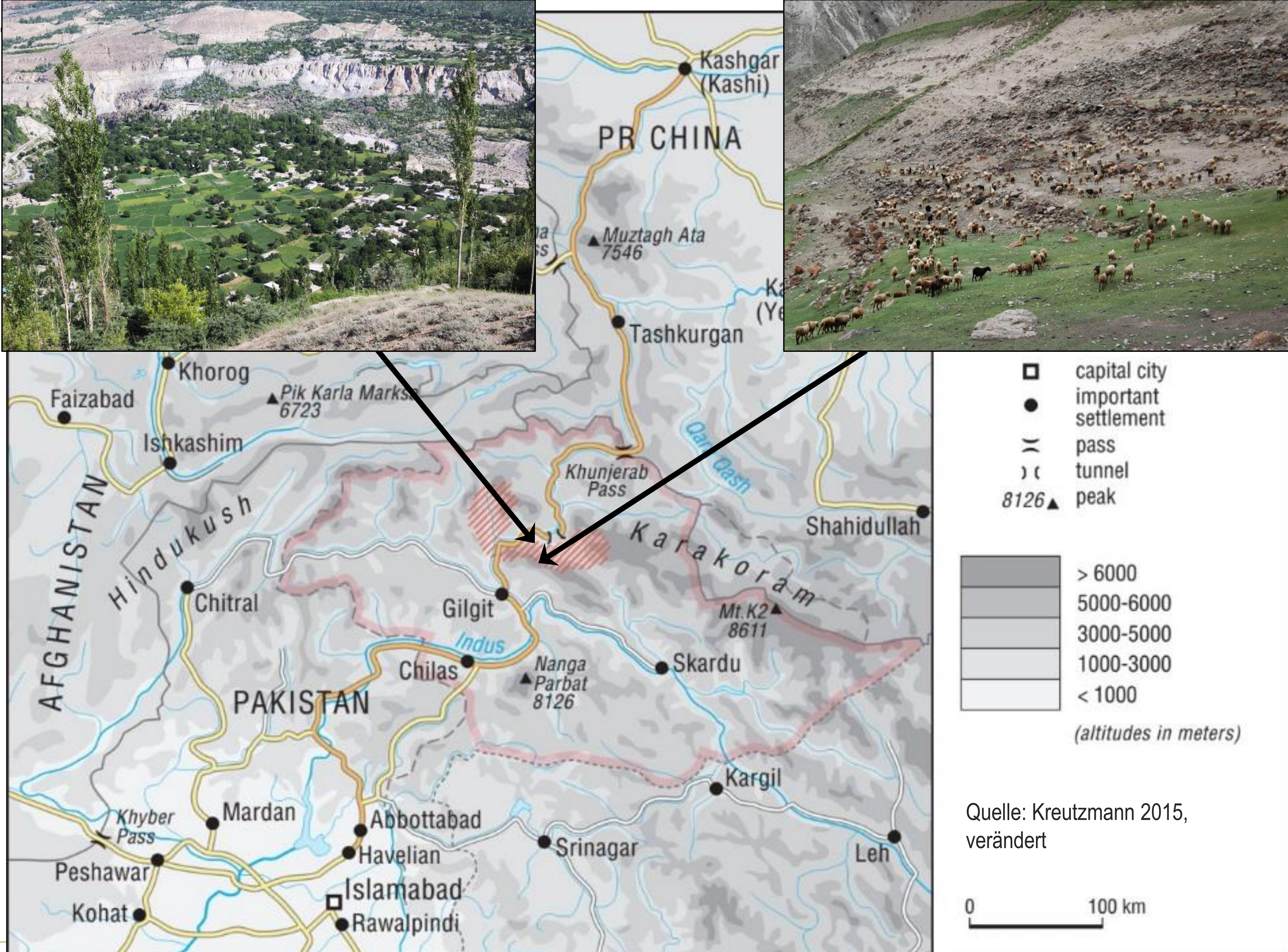
Figure 5: **Meteorological stations in the HKH region (in blue)**



Source: ICIMOD

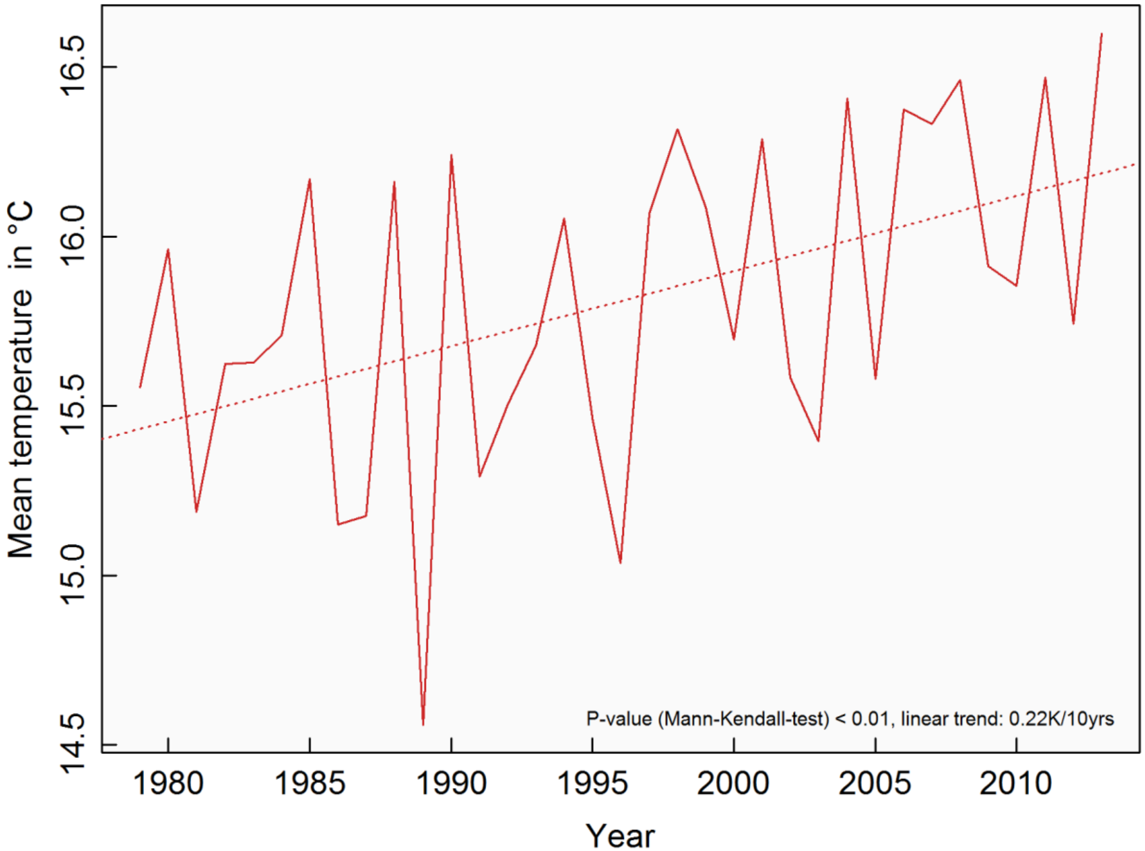
Singh et al. 2011

- Mountains of High Asia: High microclimatic variation, but low density of meteorological observations
  → Challenges validity of trend analysis and climate projections in the region



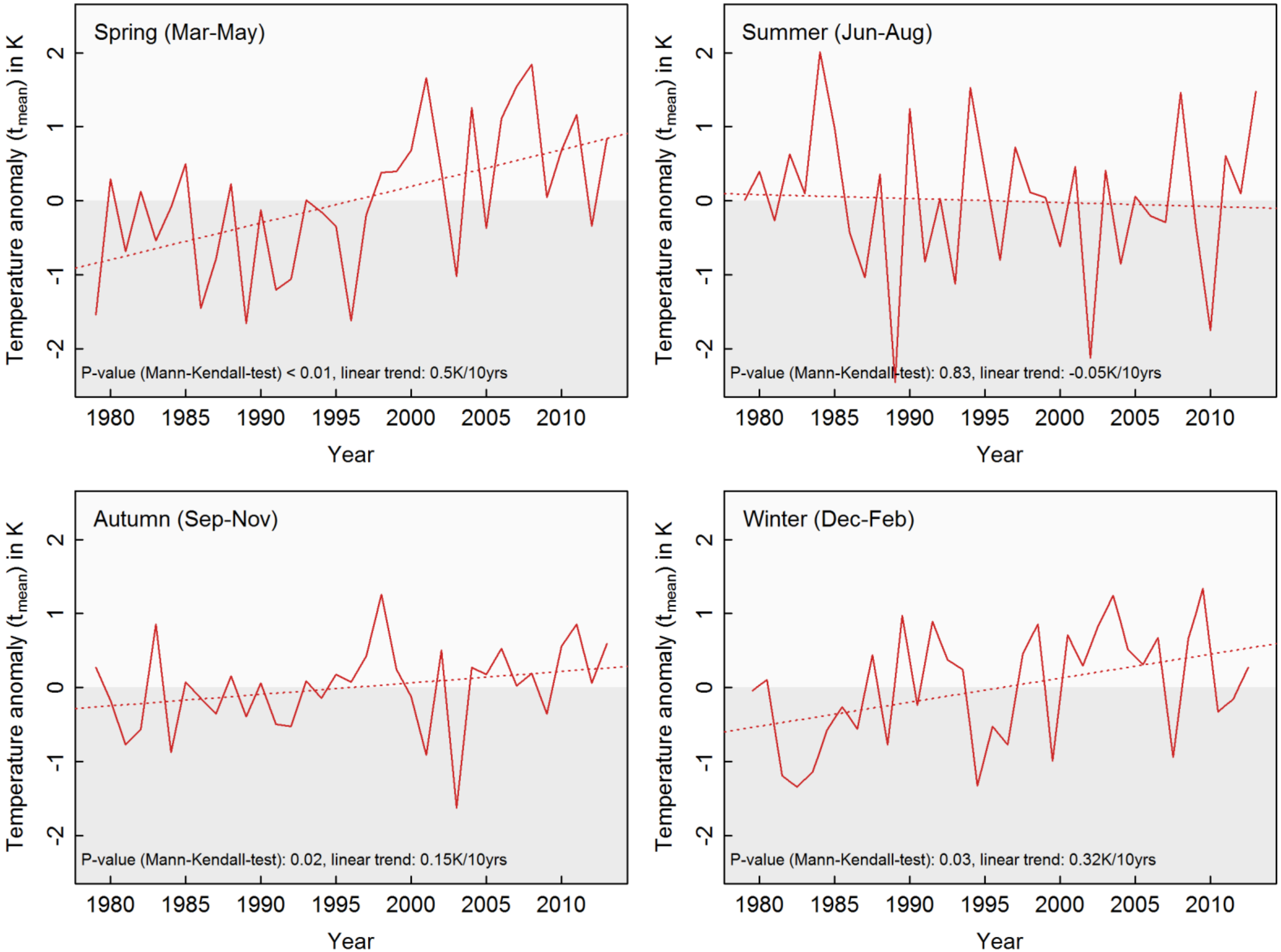
Quelle: Kreutzmann 2015, verändert

Annual temperature in Gilgit, 1979-2013



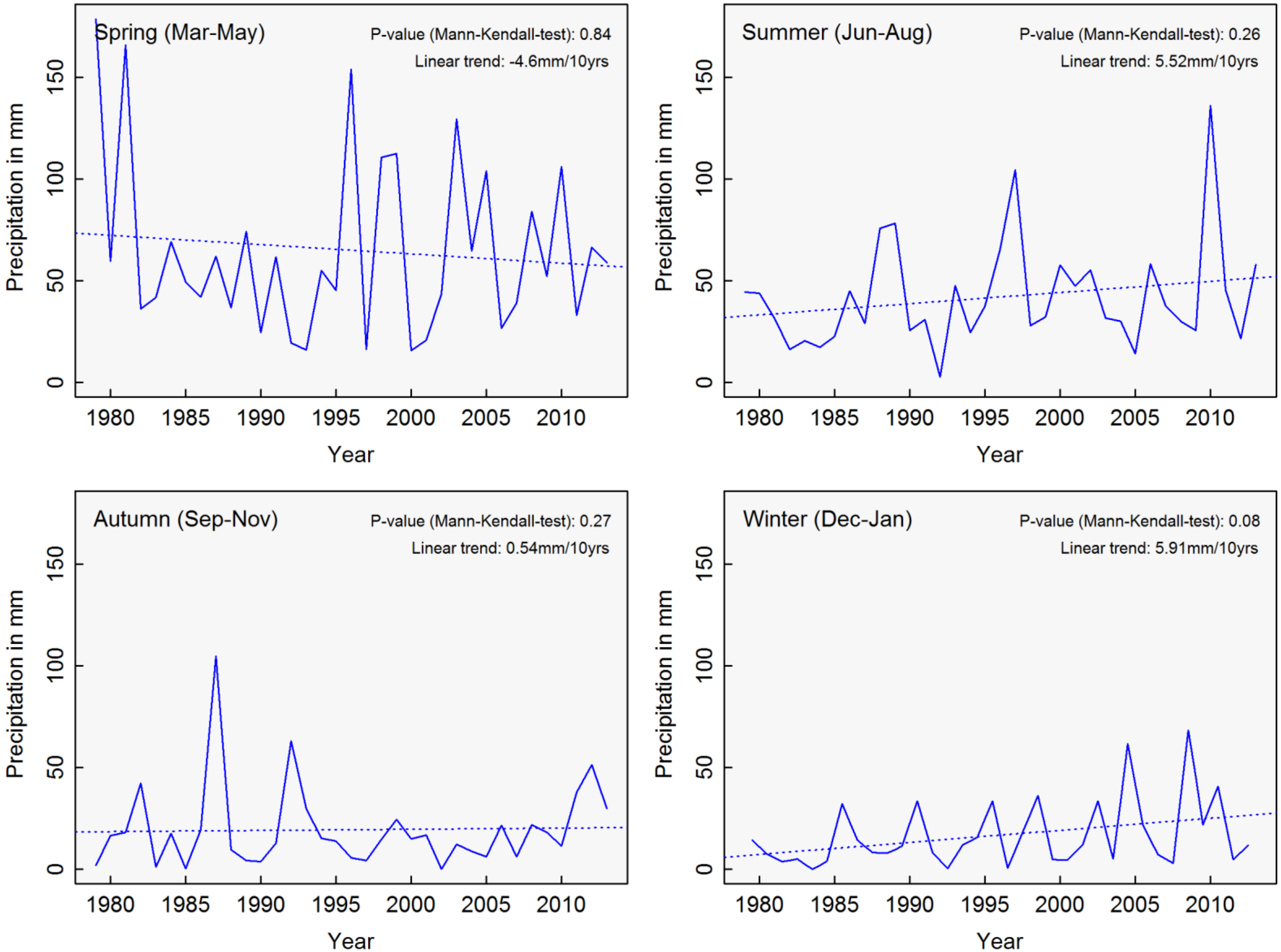
Data source: Pakistan Meteorological Department

Seasonal temperature anomalies in Gilgit, 1979-2013



Data source: Pakistan Meteorological Department

Seasonal precipitation in Gilgit, 1979-2013



Data source: Pakistan Meteorological Department

Glacier changes as a proxy for monitoring climate change

- Karakoram region: largest glacial ice cover outside the polar regions
- Glacier monitoring & assessment of changes as a proxy for climatic changes?

→ use of remote sensing

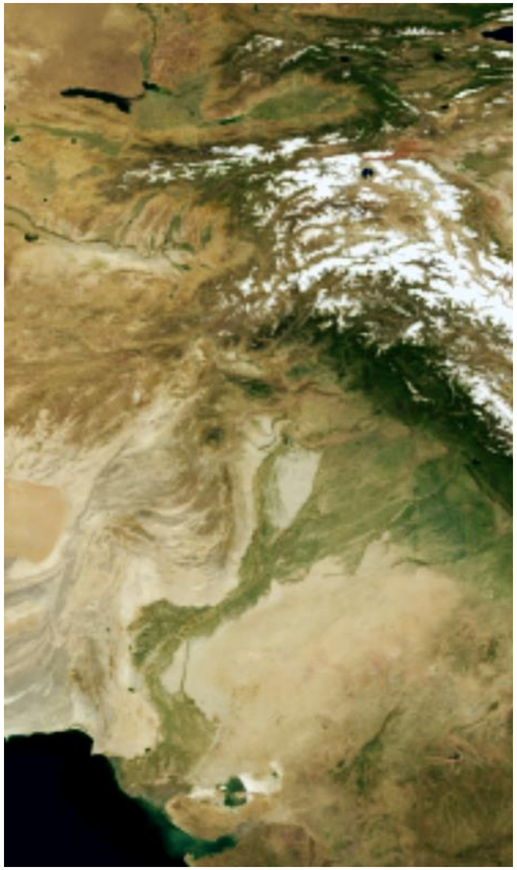
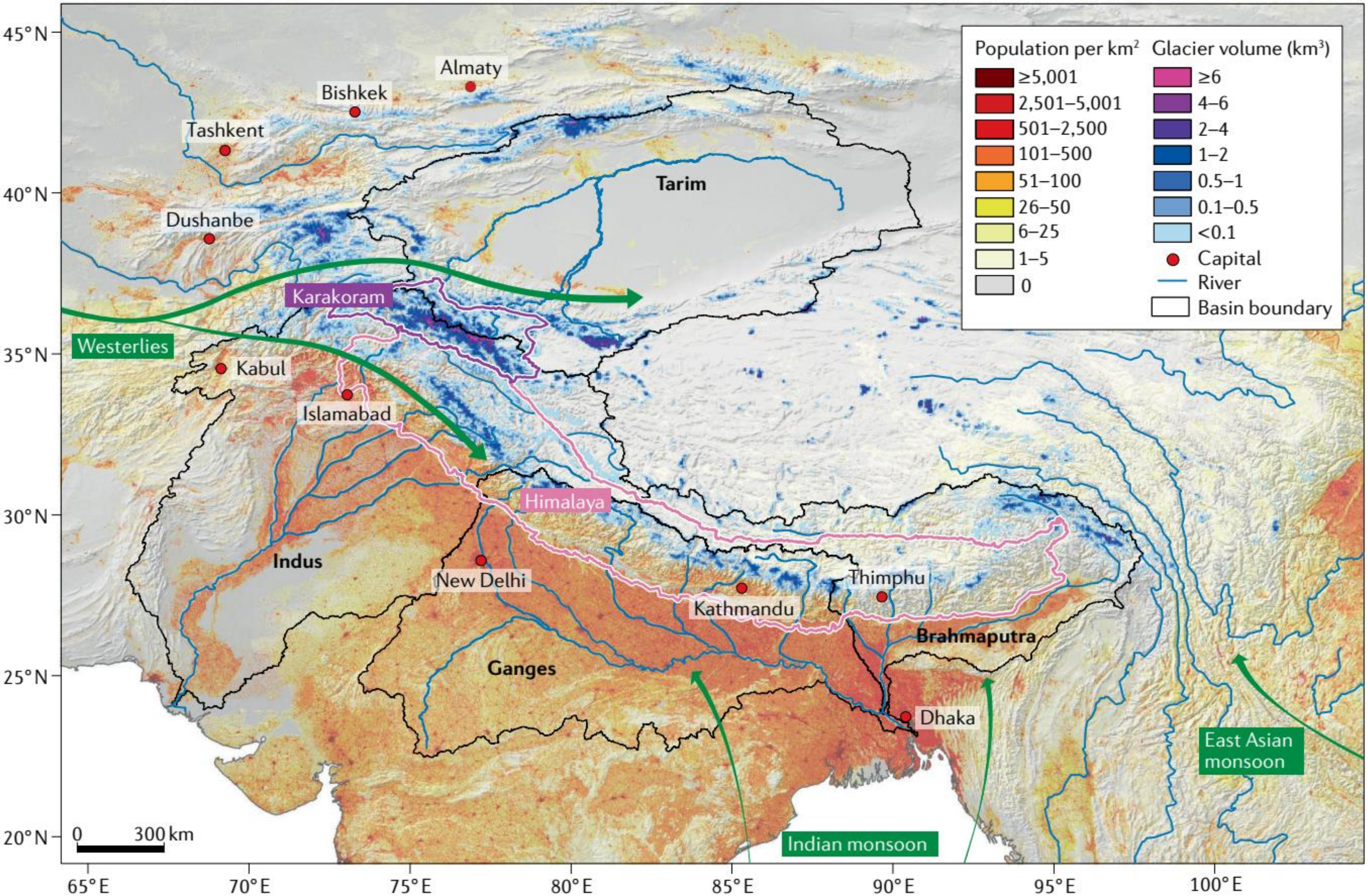


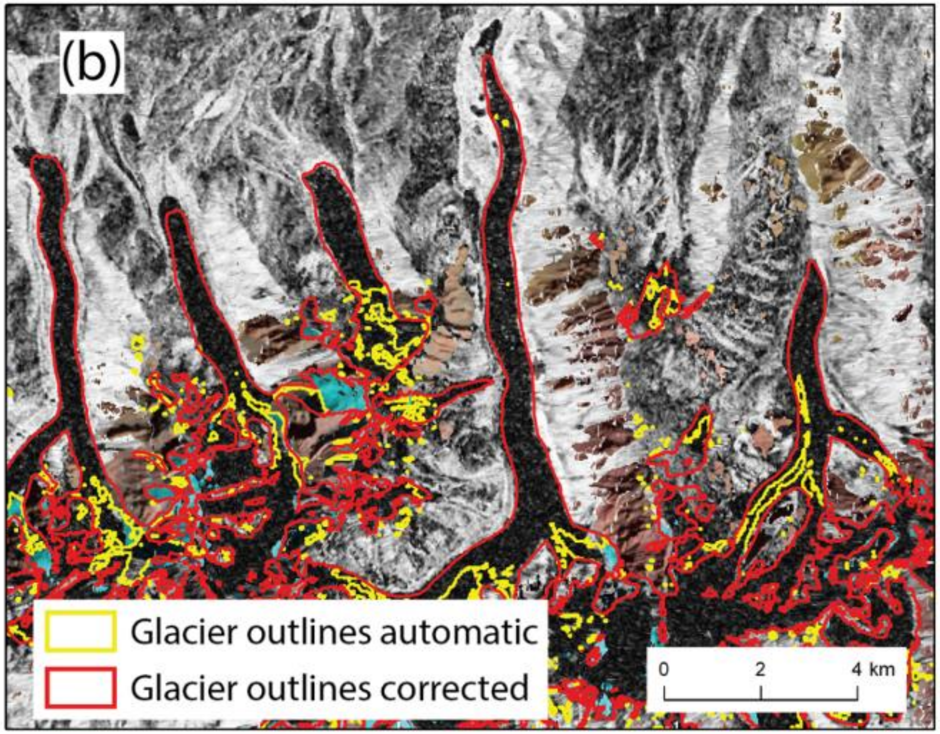
Image Source: NASA Blue Marble



Source: Nie et al. 2021

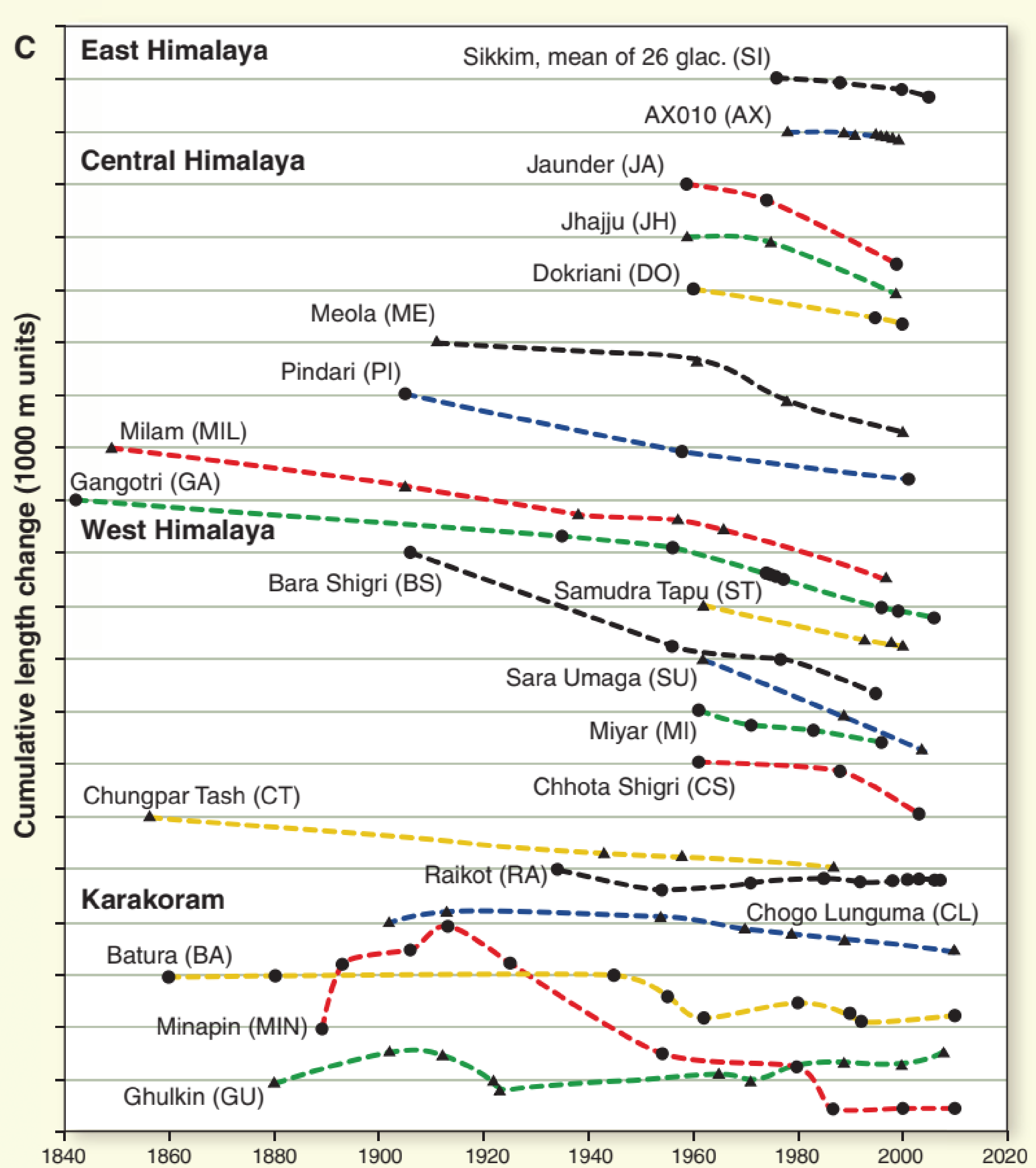
Glacier monitoring with remote sensing

- Common approach:
  Mapping of glacier extent based on Landsat and Sentinel imagery with relatively high spatial solution (10-30m)



Source: Mölg et al. 2018

- Mapping glacier extent and their temporal changes → detecting dynamics of glacier retreat and expansion
- But: Glacier mass balance more important for long-term water availability in the Indus Basin

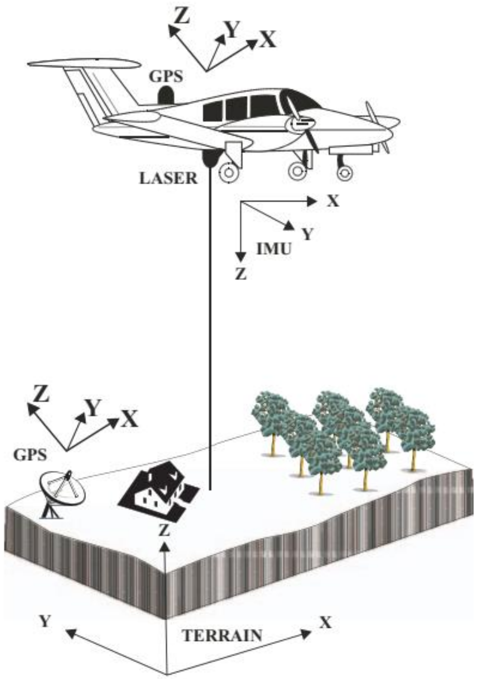


Source: Bolch et al. 2012

Analysing glacier mass balance with remote sensing

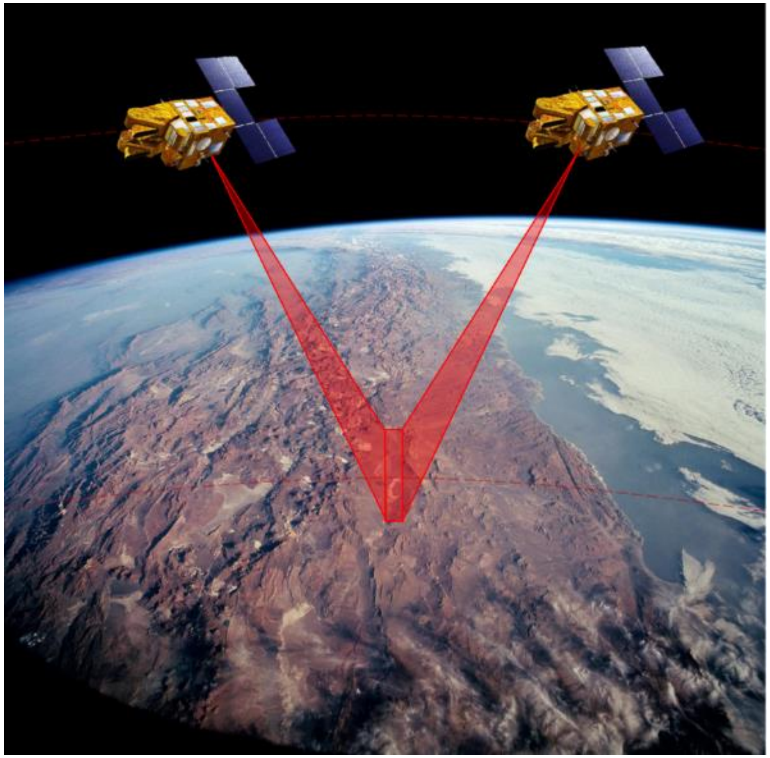
- Glacier "thinning":
  Elevation changes can be detected with difference remote sensing methods

Radar



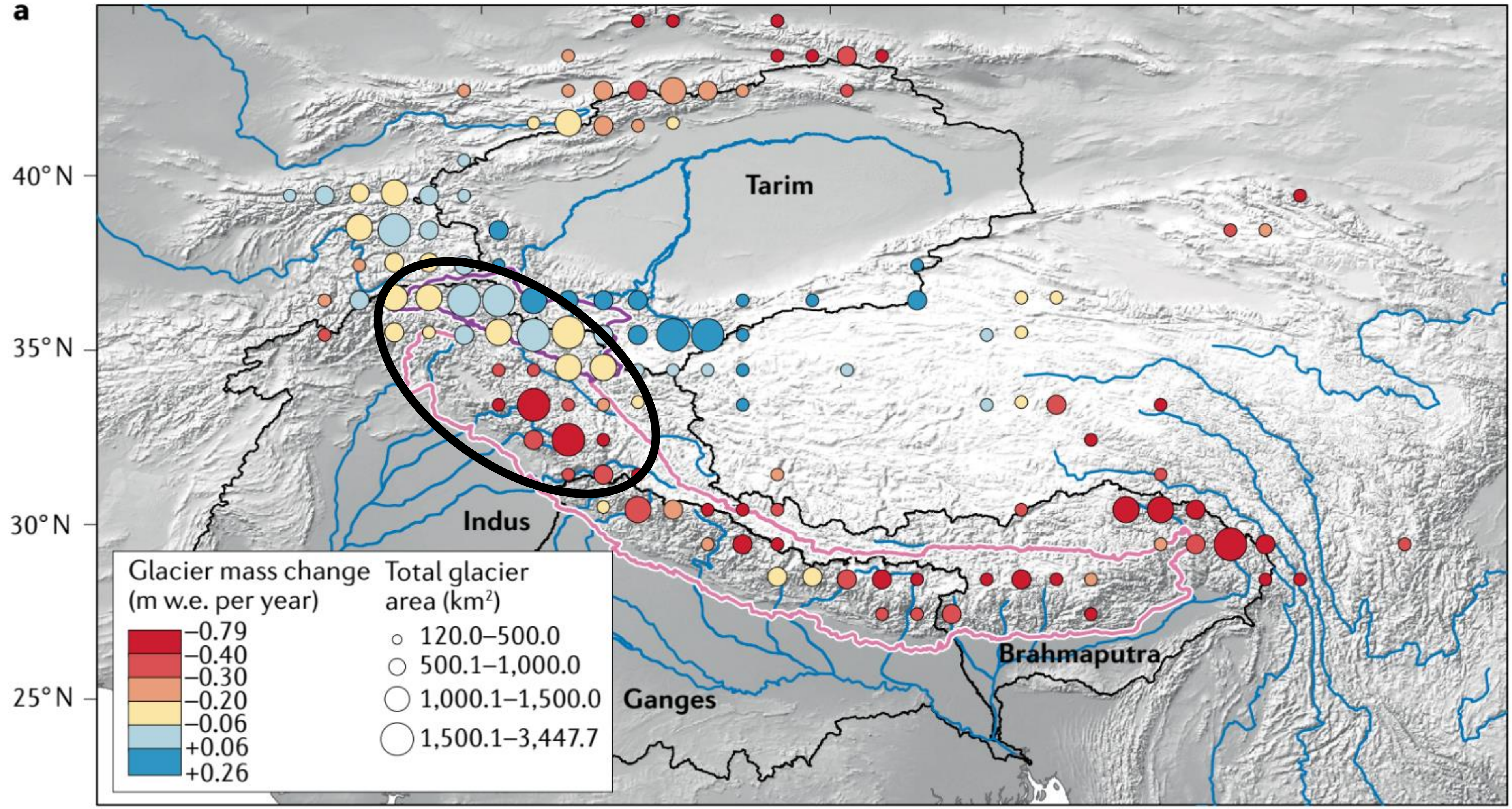
Source: Tempfli et al. 2009

Stereo imagery



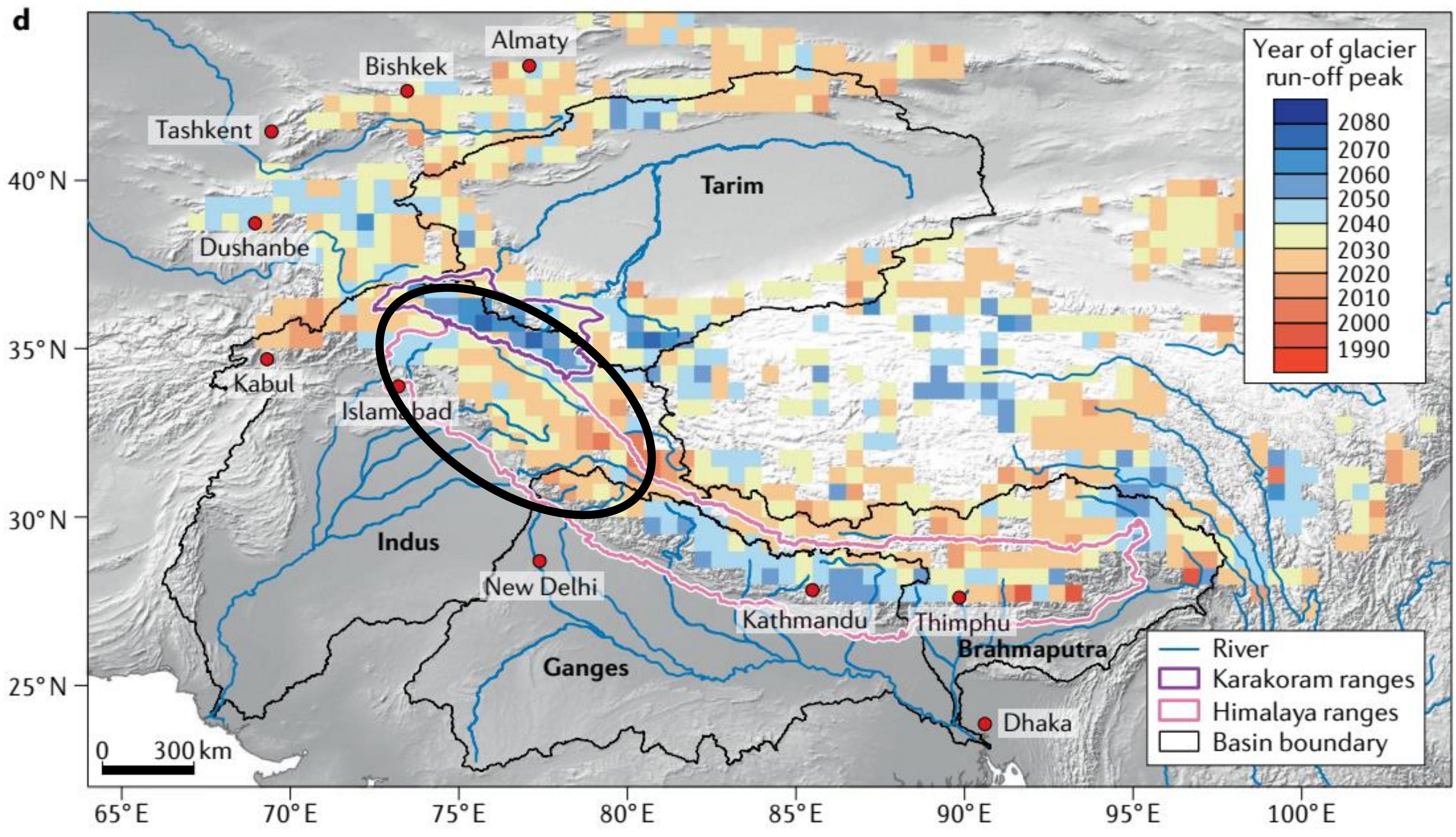
Source: https://awildgeographer.wordpress.com

Changes in glacier mass balance, 2000-2016, based on a model using elevation data derived from ASTER stereo time series data



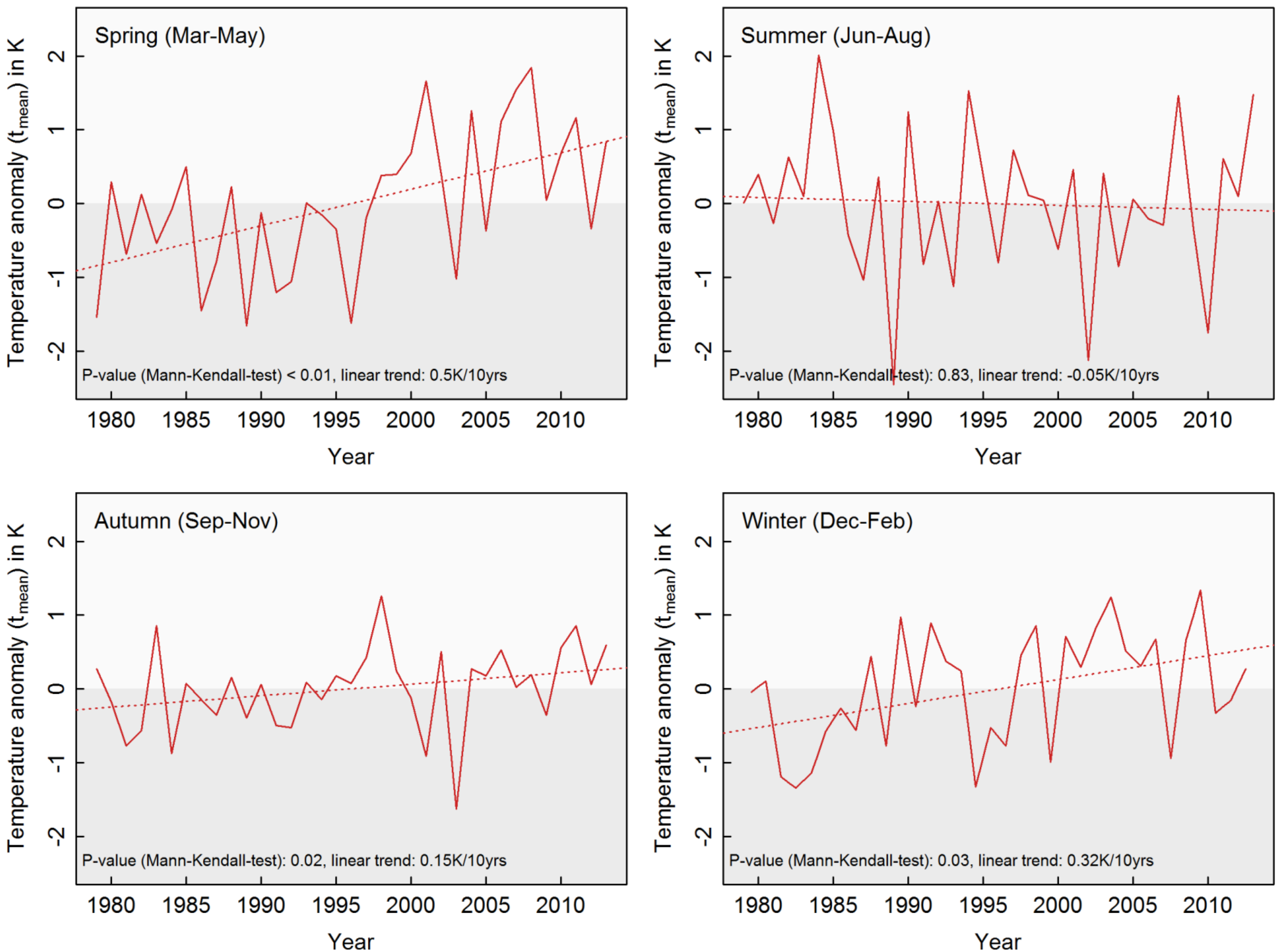
Source: Nie et al. 2021

Projected year of glacier run-off peak in the RCP 4.5 climate change scenario

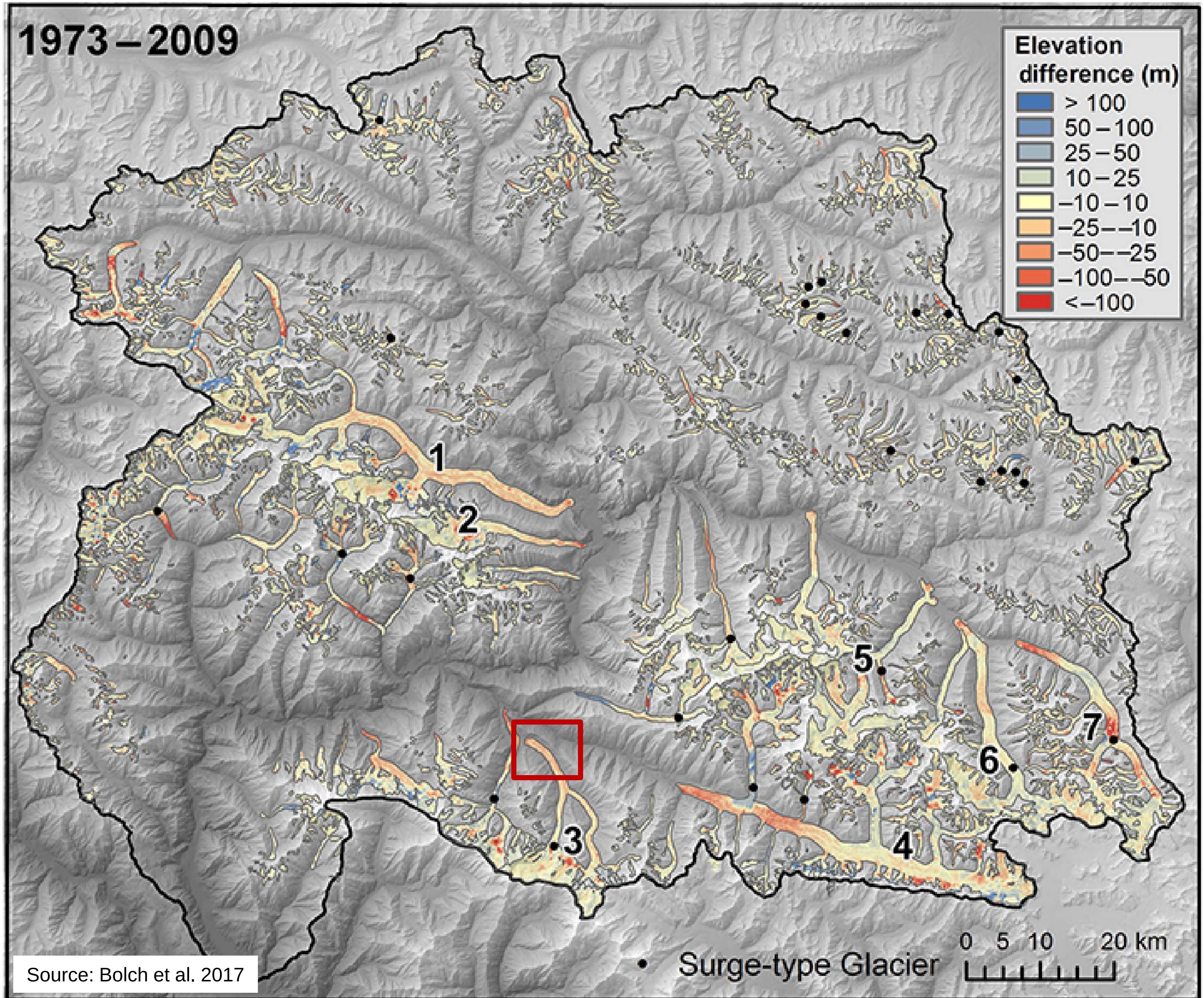


Source: Nie et al. 2021

Changes in annual temperature in Gilgit, 1979-2013



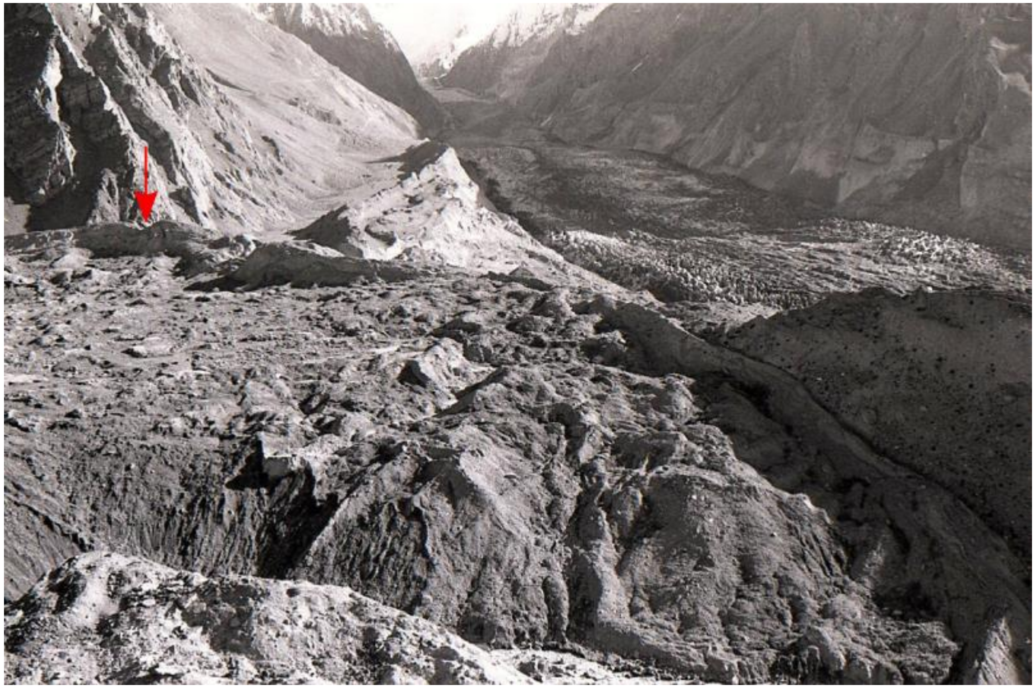
Data source: Pakistan Meteorological Department



Source: Bolch et al. 2017

Barpu Glacier, Hopar, 1987

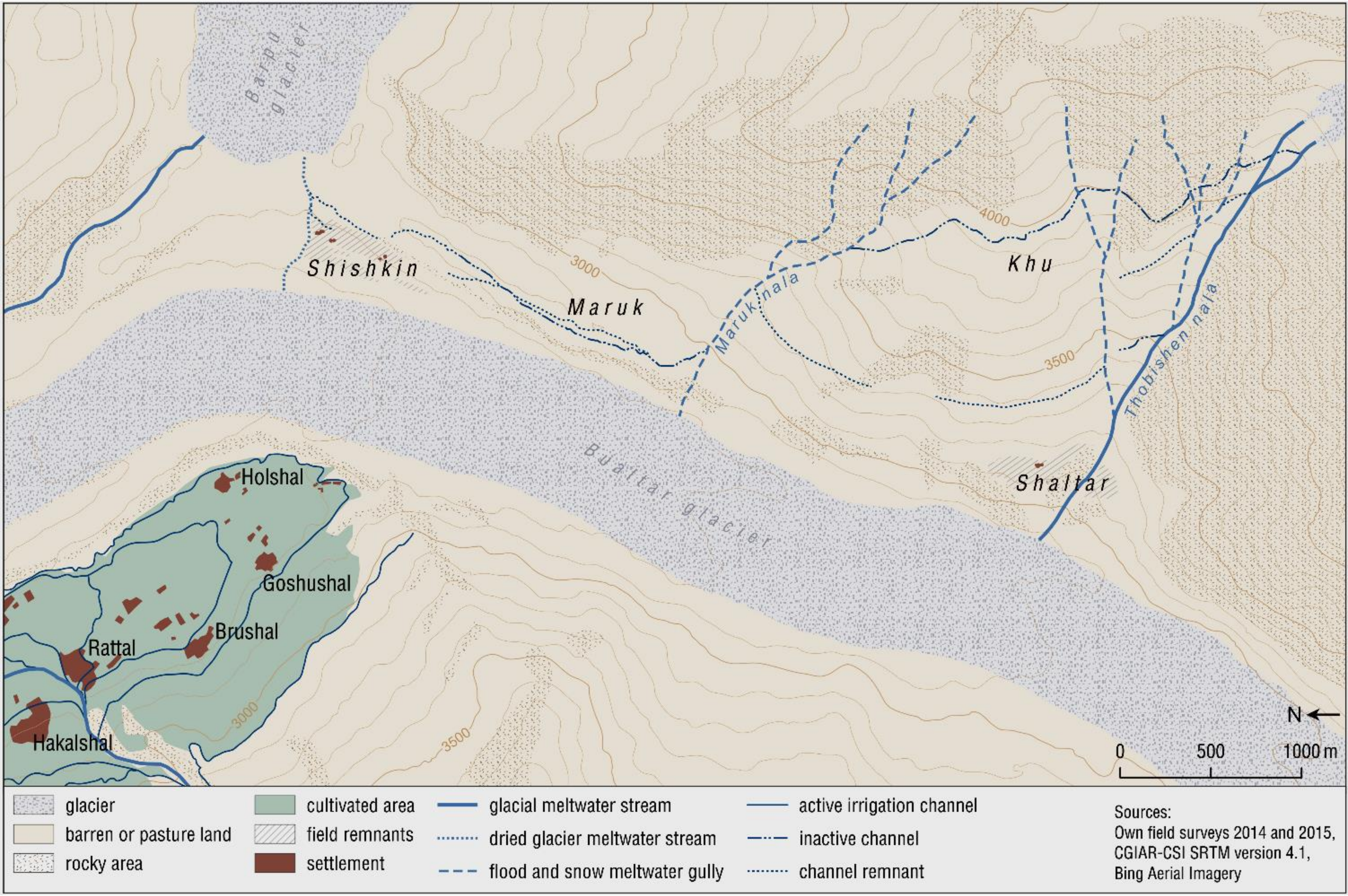
(Photo: K. Hewitt)



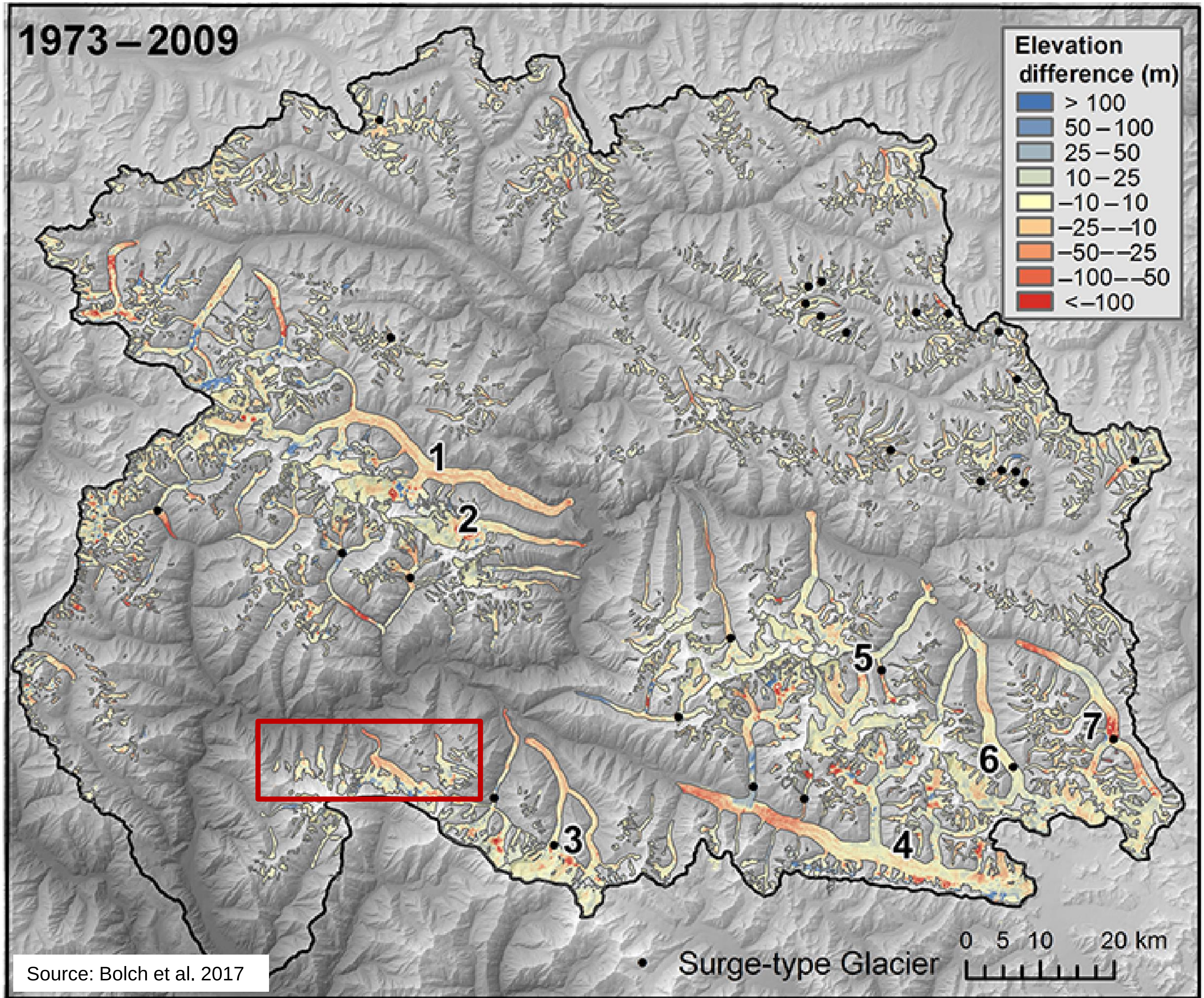
Barpu Glacier, Hopar, 2015

(Photo: M. Spies)

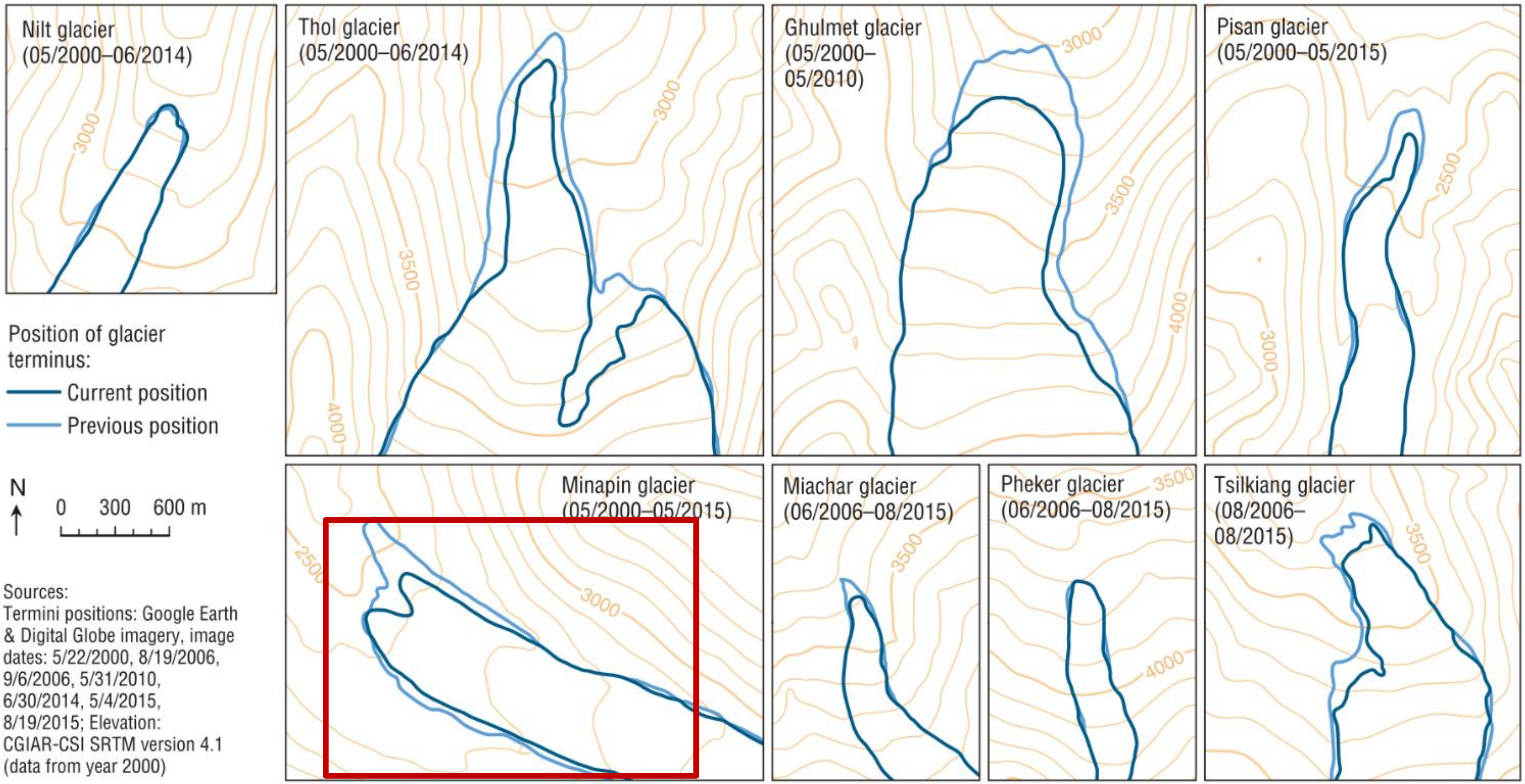
Barpu glacier and barren land of Shishkin, April 2015



Source: Spies 2016



Source: Bolch et al. 2017

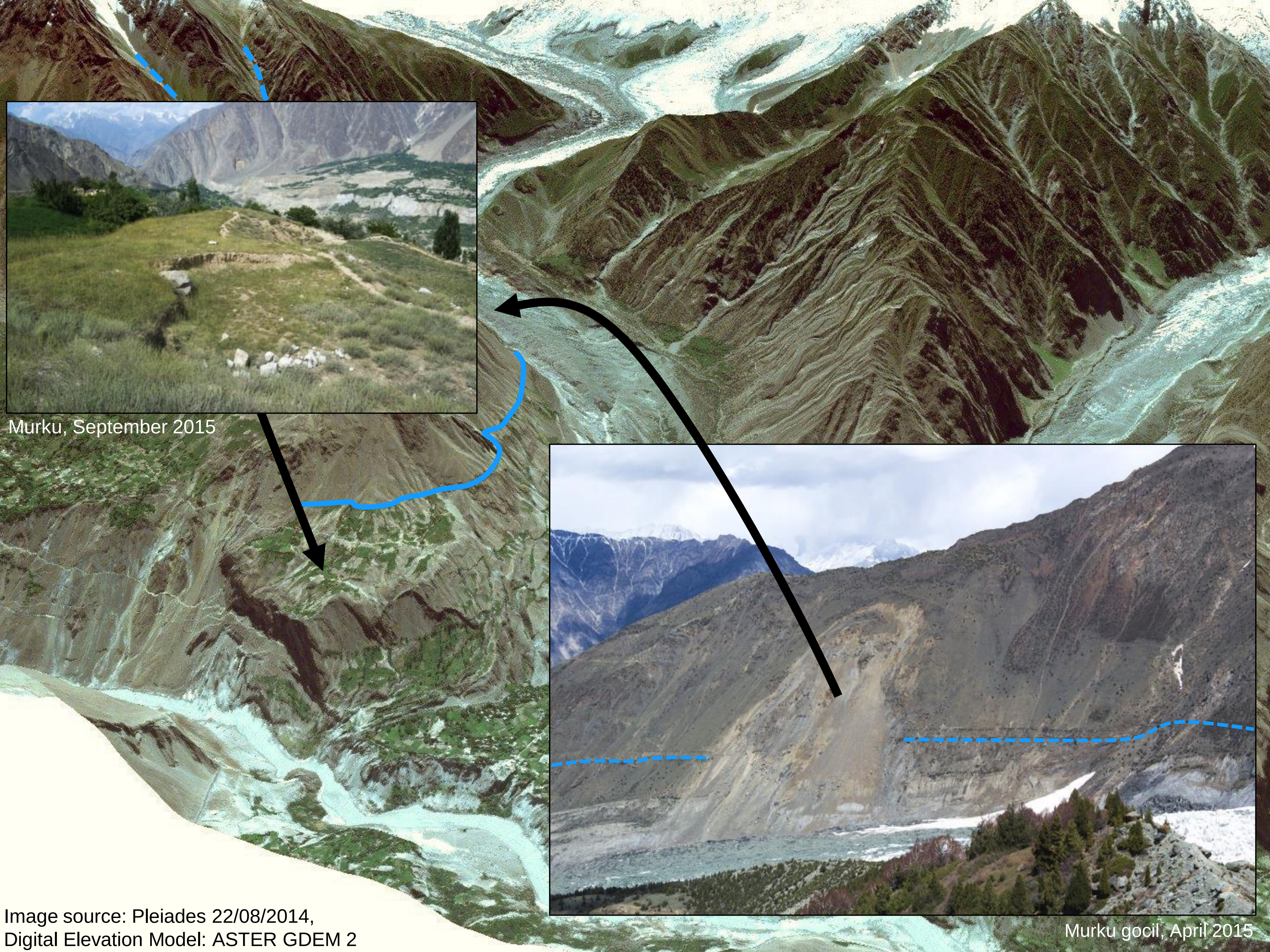


Source: Spies 2020

Image source: Pleiades 22/08/2014,
Digital Elevation Model: ASTER GDEM 2

Photo: Raja Liaqat Khan 1994

Image source: Pleiades 22/08/2014,
Digital Elevation Model: ASTER GDEM 2


Murku, September 2015
Murku gocil, April 2015
Image source: Pleiades 22/08/2014,
Digital Elevation Model: ASTER GDEM 2

Thank you!

Minapin, March 2015

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Mixed manifestations of climate change in high mountains: insights from a farming community in northern Pakistan

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ABSTRACT
This article draws on observations by local farmers to analyse changes in climate and their effects on mountain farming in the Karakoram of northern Pakistan, where little scientific knowledge about the local manifestations of climate change exists. It shows that farmers clearly perceive a warming trend in the valleys that has led to a significant reduction of snowfall and snow cover over the last 30–40 years, while observations of rainfall changes are rather mixed. These perceptions are in line with trends detected at the nearest weather station with long-term observations. In contrast to common assumptions about climate change impacts in this high mountain region, the local effects of these changes are rather diverse and strongly depend on microclimatic and other factors: while many farmers acknowledge improved cropping conditions due to an extended agricultural season, a slight majority of respondents evaluate the observed changes in rather negative terms, among others due to an aggravated water scarcity in spring. The findings highlight the importance of local contexts and show that especially in mountain regions, general assumptions about climate change impacts should be avoided.

ARTICLE HISTORY
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KEYWORDS
Climate change; perception; high mountains; agriculture; Pakistan

1. Introduction

People living in high mountain regions of the Global South are considered particularly vulnerable to climate change, as these environments are prone to natural hazards and characterized by sensitive ecosystems and microclimatic regimes (Eriksson et al., 2009; Kohler, Wehrli, & Jurek, 2014; Monreal & Stötter, 2014; Palomo, 2017; Schild & Sharma, 2011). Beyond this general acceptance, however, there is still a lack of knowledge of the local manifestations of climate change and their impacts in high mountains, as climate data is often scarce and human-environmental relations are complex and characterized by great diversity (Kohler et al., 2014; Singh, Bassignana-Khadka, Karky, & Sharma, 2011, p. 12).

A case in point is the high mountain region of Gilgit-Baltistan, northern Pakistan, where limited empirical evidence on climate change impacts has given rise to rather generalizing and speculative statements based on patterns found in other mountain regions. For instance, melting glaciers are often highlighted as a major threat to Gilgit-Baltistan (Sandeelo, 2018; UNDP, 2016; Volkmer & Sharif, 2018), ignoring the fact that the Karakoram range dominating the region has shown no

of erratic weather' (Shaikh, 2013) and climate change makes the whole region a 'ticking bomb' (Mir, 2016).

The problem with such statements is not only their missing scientific basis but also that they can have adverse implications on development policies and practice. Suggesting that climate change is the dominant problem for local communities, these narratives risk downplaying other, possibly more pressing social, economic and political challenges that people must deal with. Based on new empirical evidence from field research in a mountain community in the western Karakoram, this article attempts to take a more critical look at the manifestations of climate change from a local perspective. Assuming that agriculture is a sector most susceptible to climate change, it investigates the perceptions of recent climatic trends and related effects on high mountain agriculture by local farmers. Drawing on data from a nearby weather station for the period 1978–2013 and semi-structured interviews with a total of 105 elder farmers and other local informants, two research questions are addressed: What changes in local climate can be observed in the western Karakoram in recent decades? In what ways – negatively and positively – have these changes affected farming systems? As will be shown, local perspectives might differ

Perceived changes in climate

Type of change / indicator	Number of mentions (without/with probing)
decrease in snowfall / snow cover	62 (92)
general warming	21 (28)
warmer winters	9 (15)
hotter summers	1 (3)
increase in rainfall decrease in rainfall no change in rainfall	8 (13) 11 (27) 0 (8)
increase in wind decrease in wind	1 (1) 0 (2)
increase in thunderstorms	2 (2)
increase in weather variability decrease in weather variability	1 (1) 1 (1)
earlier blossoming of apricot trees later blossoming of apricot trees no change in blossoming of apricot trees	0 (15) 0 (4) 0 (5)

Source: 105 semi-structured interviews with respondents between the age of approx. 40 and 95 years