



# Cryosphere and related hazards in High Mountain Asia in a changing climate

1–4 November 2022 | Almaty, Kazakhstan

Presenter(s): SHER MUHAMMAD

Date: 3 November 2022

# Meltwater variability and its downstream impacts in the Indus Basin

## Published

40 papers

## Reviewer

35 journals

## Editor

PLOS One

PLOS Water

PLOS Climate

Journal of Mountain Science

Journal of Himalayan Earth Sciences

Working at



Postdoc



PhD



Previously worked



- Background
- Global Snow datasets
- Snow data quality improvement
- Case studies of improved snow data
- ❖ Anomalous snow 2020
- ❖ Below normal snow and heatwaves in 2022
- ❖ Downstream impacts
- ❖ Conclusion and recommendations
- ❖ Questions and Answers

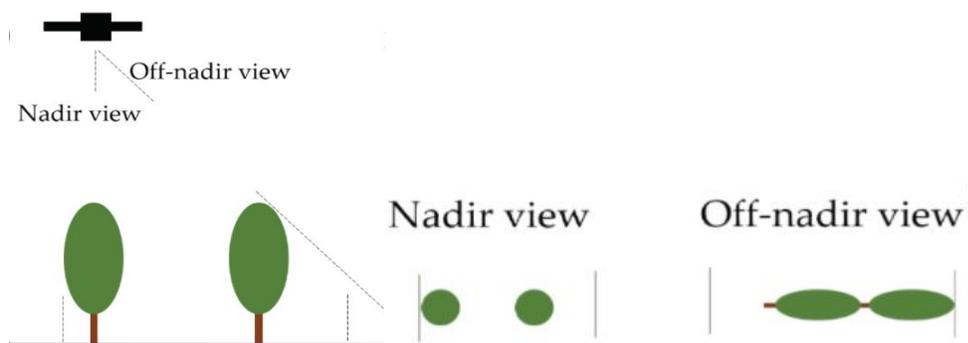
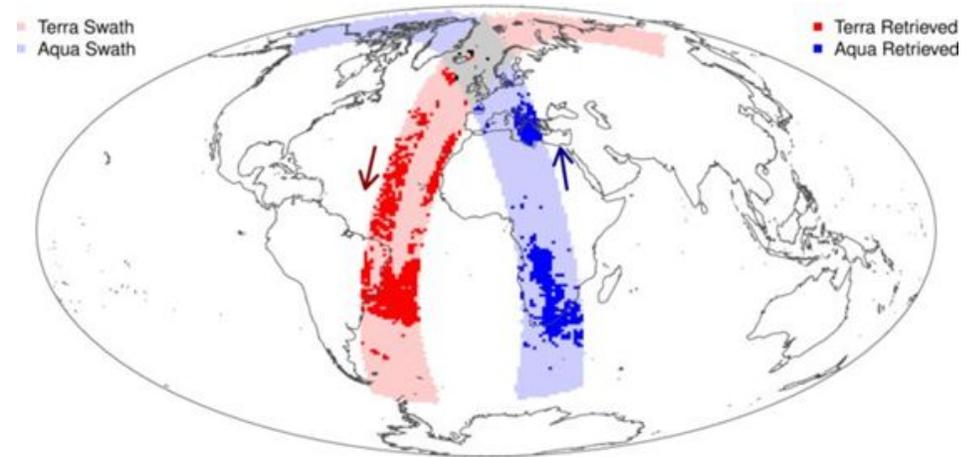
# Popular snow products

<b>Product Name</b>	<b>Terra Prod ID/ DAAC Link</b>	<b>Aqua Prod ID/ DAAC Link</b>
MODIS Snow Cover 5-Min L2 Swath 500m	<a href="#">MOD10_L2</a>	<a href="#">MYD10_L2</a>
MODIS Snow Cover Daily L3 Global 500m Grid	<a href="#">MOD10A1</a>	<a href="#">MYD10A1</a>
MODIS Snow Cover Daily L3 Global 0.05Deg CMG	<a href="#">MOD10C1</a>	<a href="#">MYD10C1</a>
MODIS Snow Cover 8-Day L3 Global 500m Grid	<a href="#">MOD10A2</a>	<a href="#">MYD10A2</a>
MODIS Snow Cover 8-Day L3 Global 0.05Deg CMG	<a href="#">MOD10C2</a>	<a href="#">MYD10C2</a>
MODIS Snow Cover Monthly L3 Global 0.05Deg CMG	<a href="#">MOD10CM</a>	<a href="#">MYD10CM</a>

<b>Product Name</b>	<b>Product ID</b>
<b>NPP/VIIRS Snow Cover 6-Min L2 Swath 375m</b>	<a href="#">VNP10</a>
<b>NPP/VIIRS Snow Cover Daily L3 Global 375m SIN Grid</b>	<a href="#">VNP10A1</a>
<b>NPP/VIIRS Snow Cover Cloud-Gap-Filled Daily L3 Global 375m SIN Grid</b>	<a href="#">VNP10A1F</a>

# Context

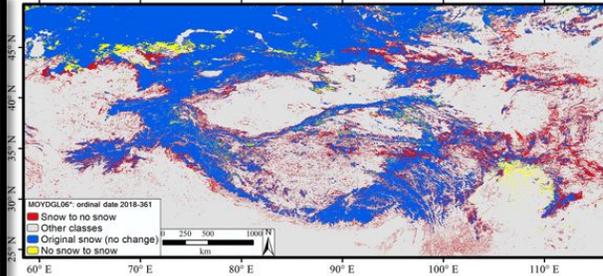
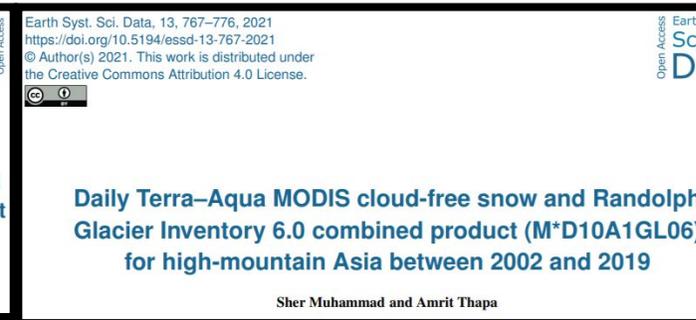
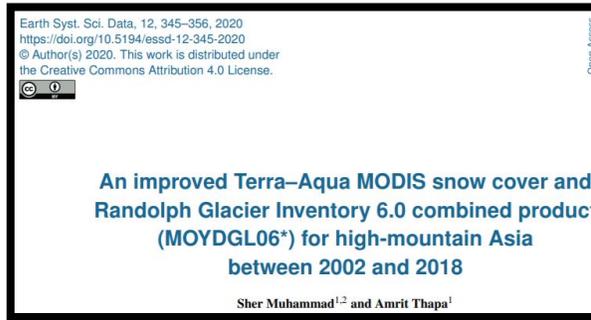
- Existing **MODIS snow products** contain **significant clouds**
- On an average **46%** of the images in High Mountain Asia are cloud cover
- Off nadir view** also causes overestimation in snow data



# Source, amount, and details of the improved product

Both the products are derived from ~500K individual satellite images for the period 2003 – 2019

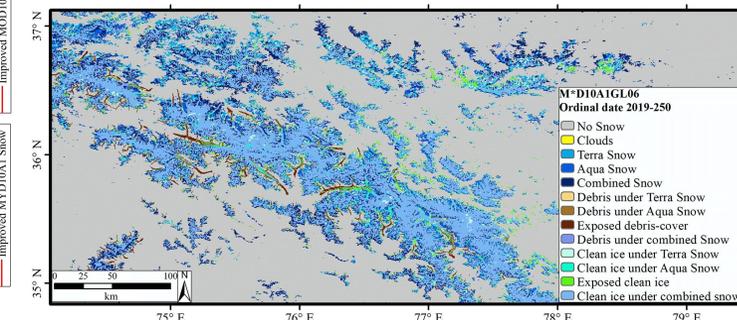
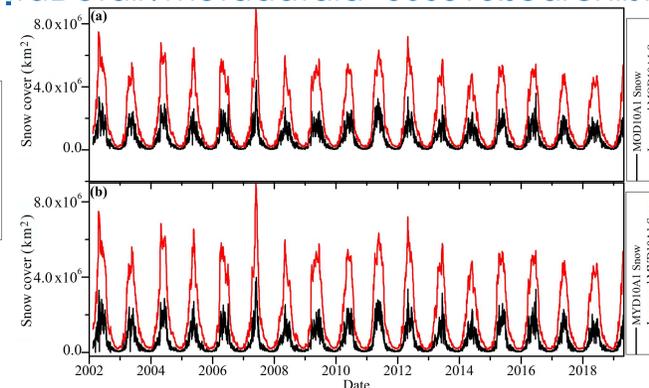
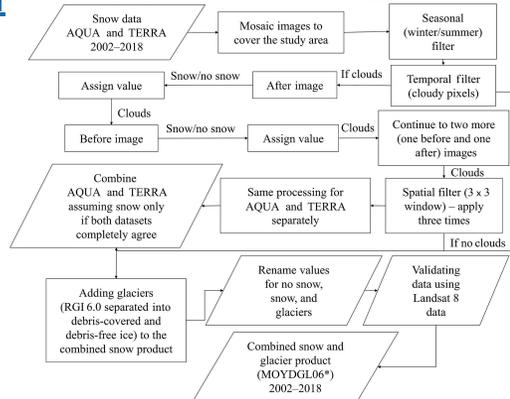
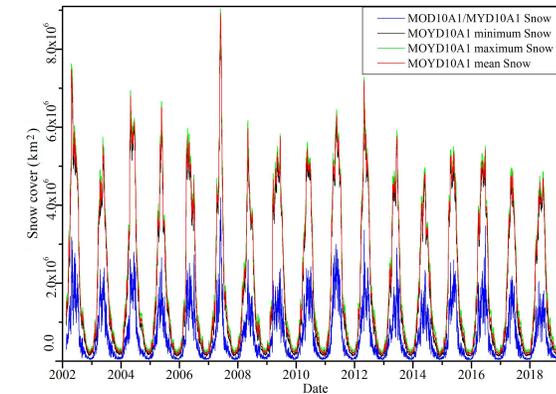
Code are available for extending the observation period

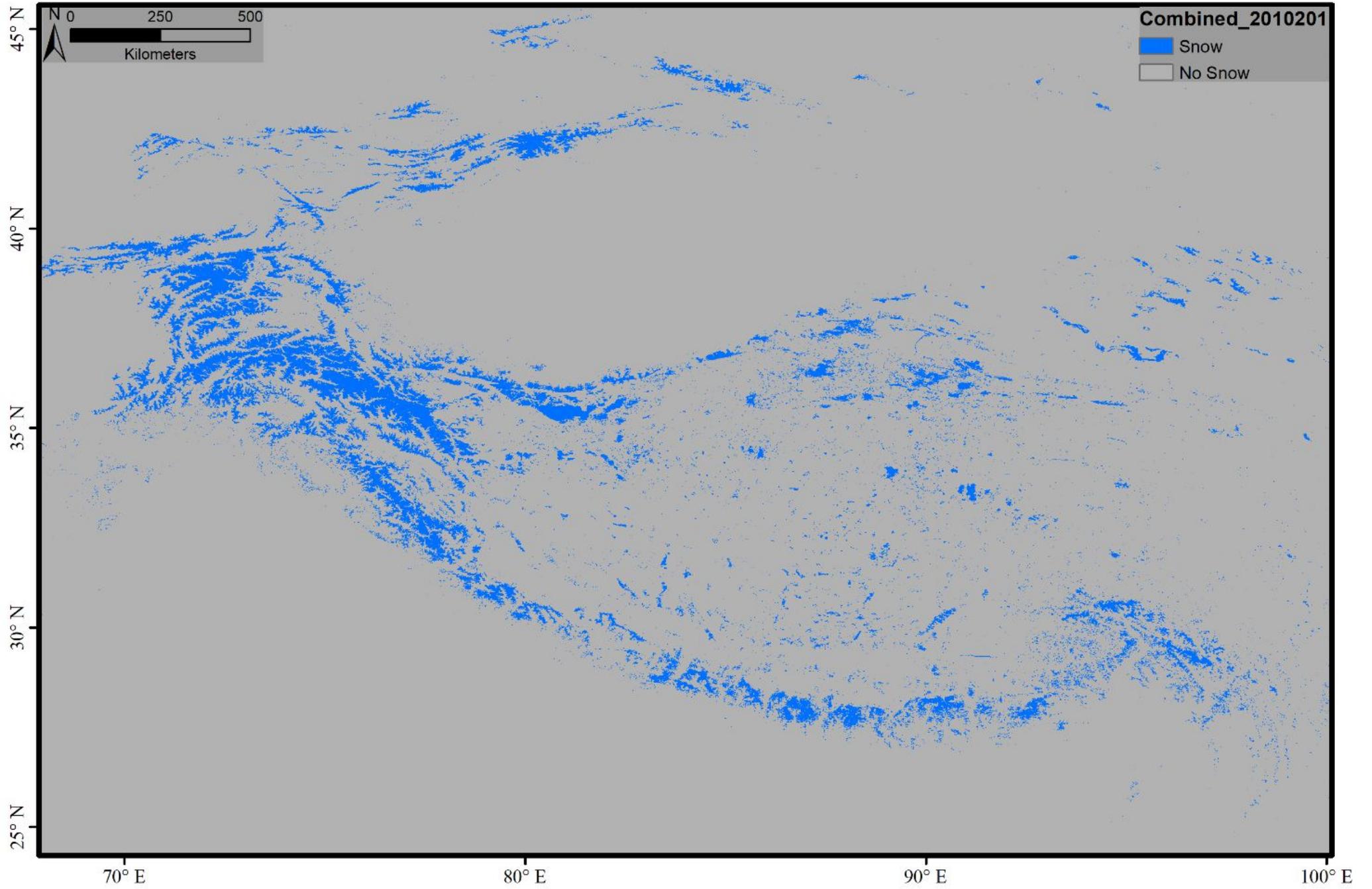


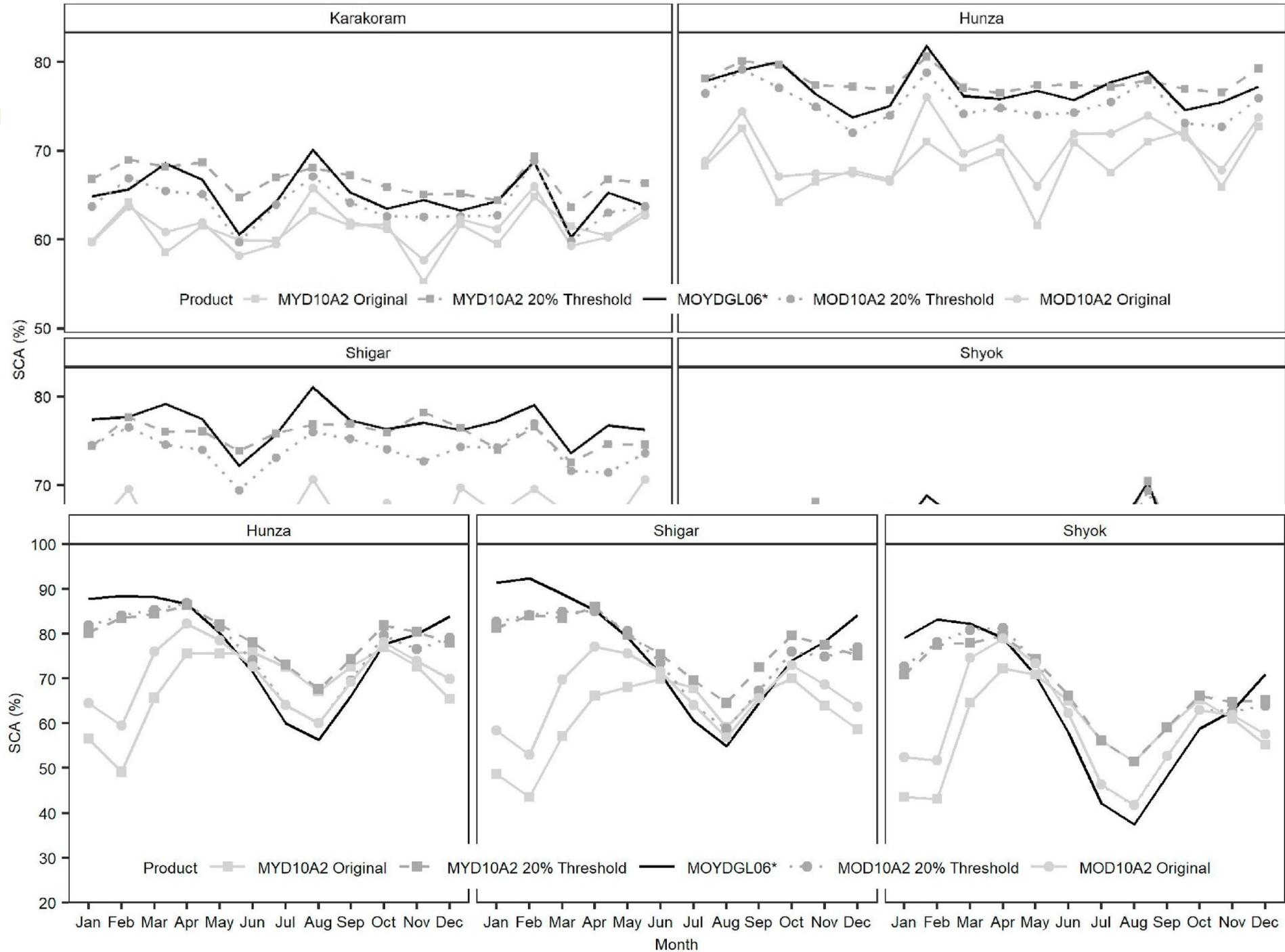
1. Earth System Science Data Journal. <http://dx.doi.org/10.5194/essd-13-767-2021>
2. Earth System Science Data Journal <http://dx.doi.org/10.5194/essd-2019-78>

## Data:

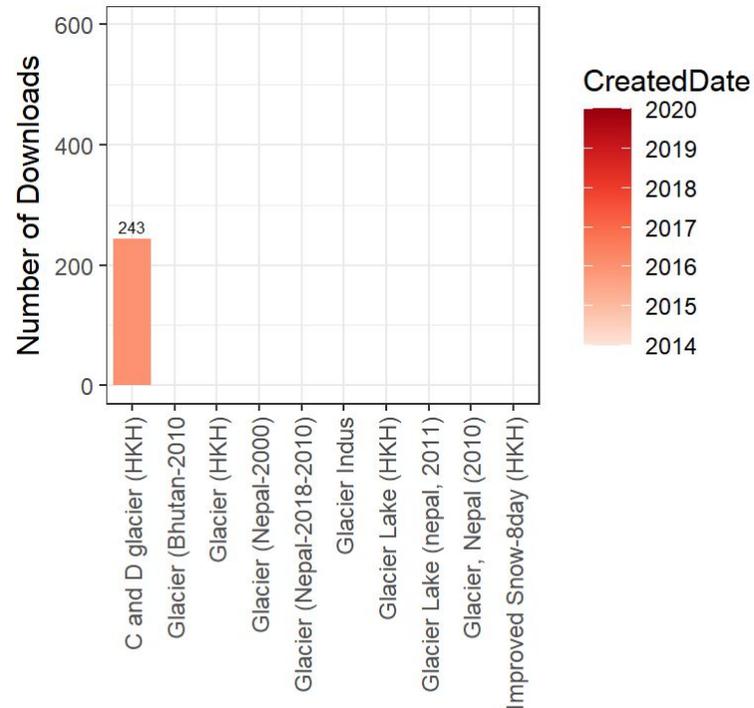
1. <https://rds.icimod.org/Home/DataDetail?metadataId=1972585&searchlist=True>
2. <https://rds.icimod.org/Home/DataDetail?metadataId=36031&searchlist=True>







# Data usage



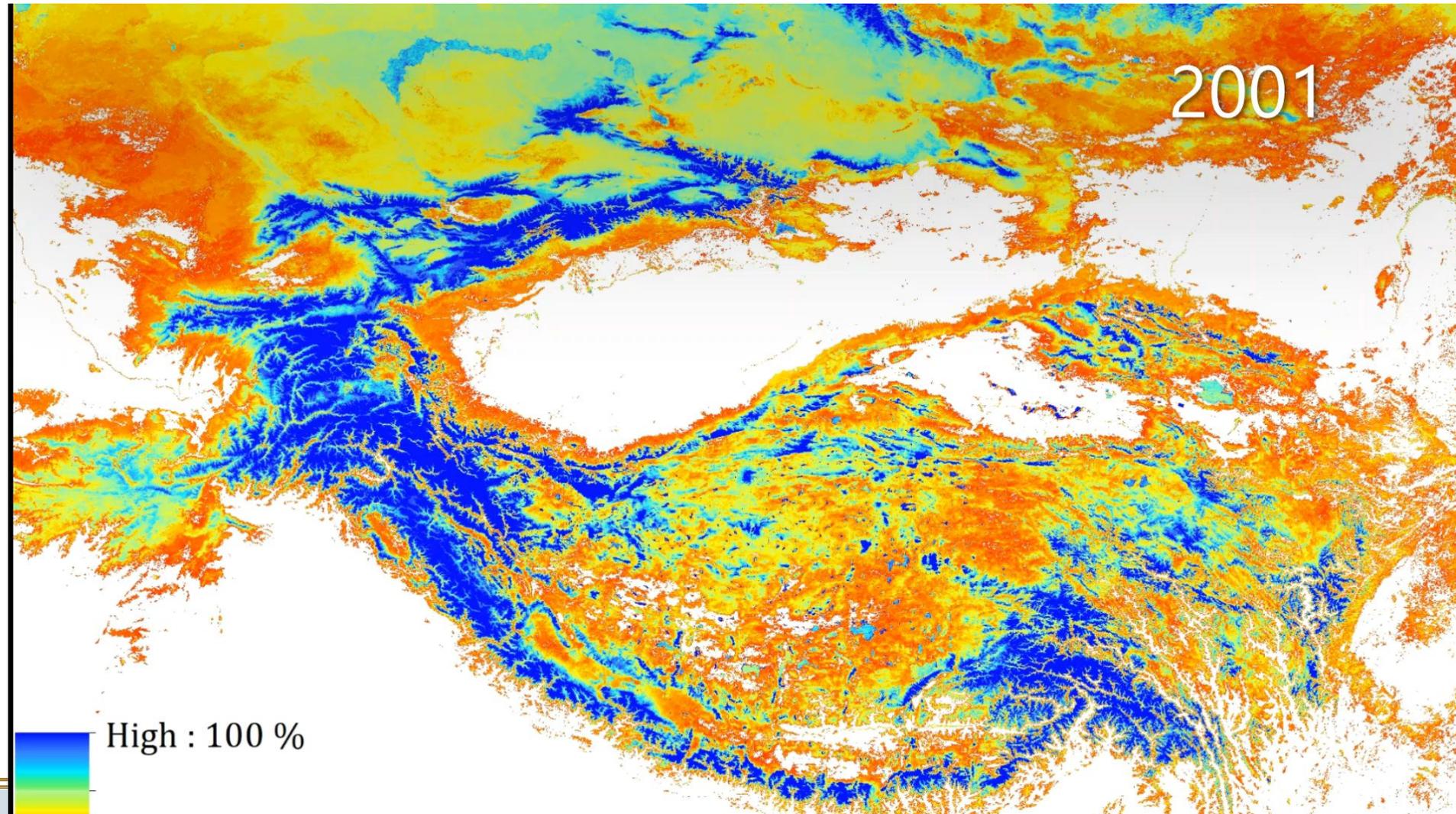
Including our snow products, a total of over **100** cryosphere datasets uploaded to ICIMOD RDS

**Over 5000** cryosphere data downloaded

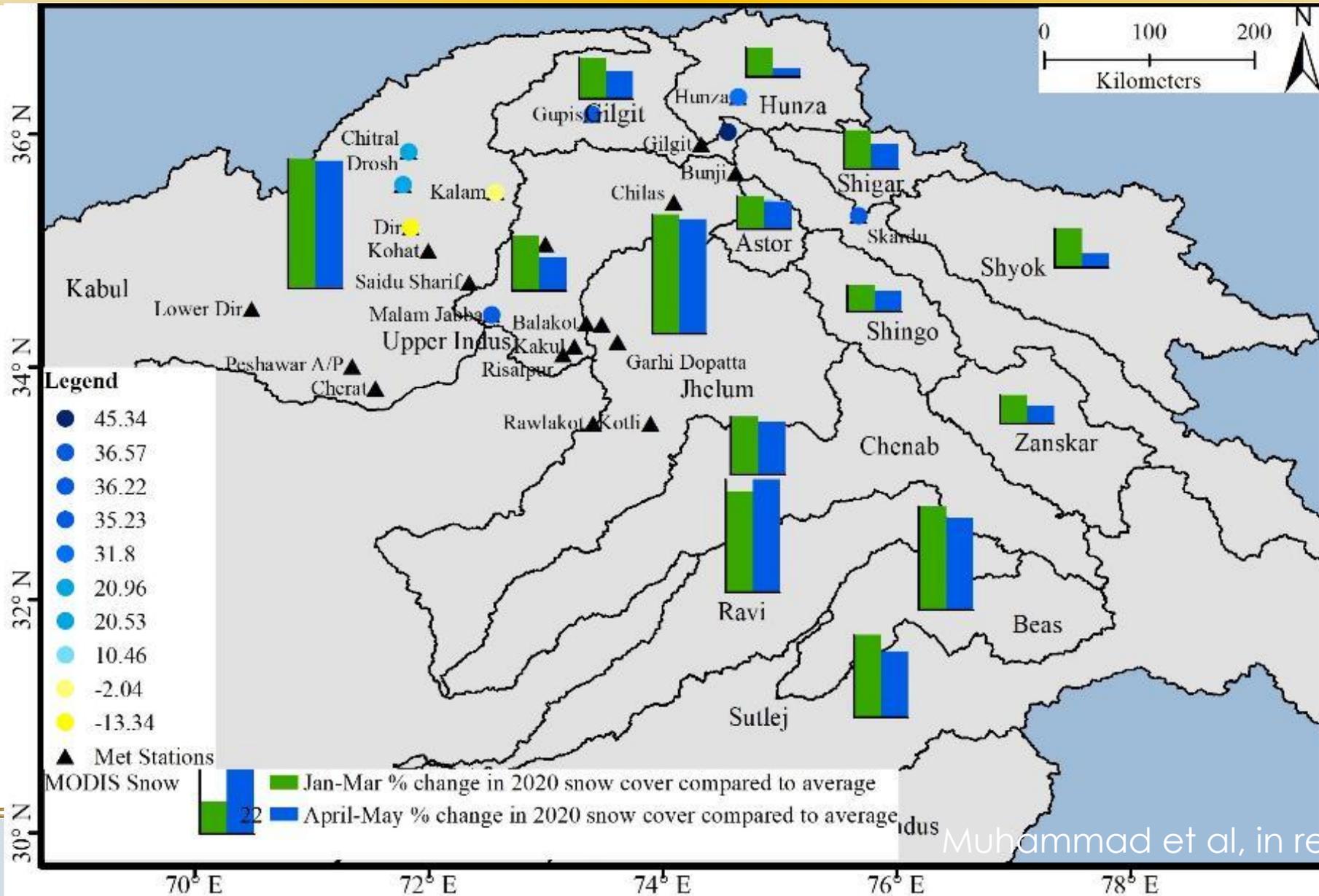
Glacier and glacier lake inventory, field-based AWS data used in several glacio-hydrological studies

Regularly sharing data with partners (Eg: DHM, Nepal)

# Improved daily MODIS snow data

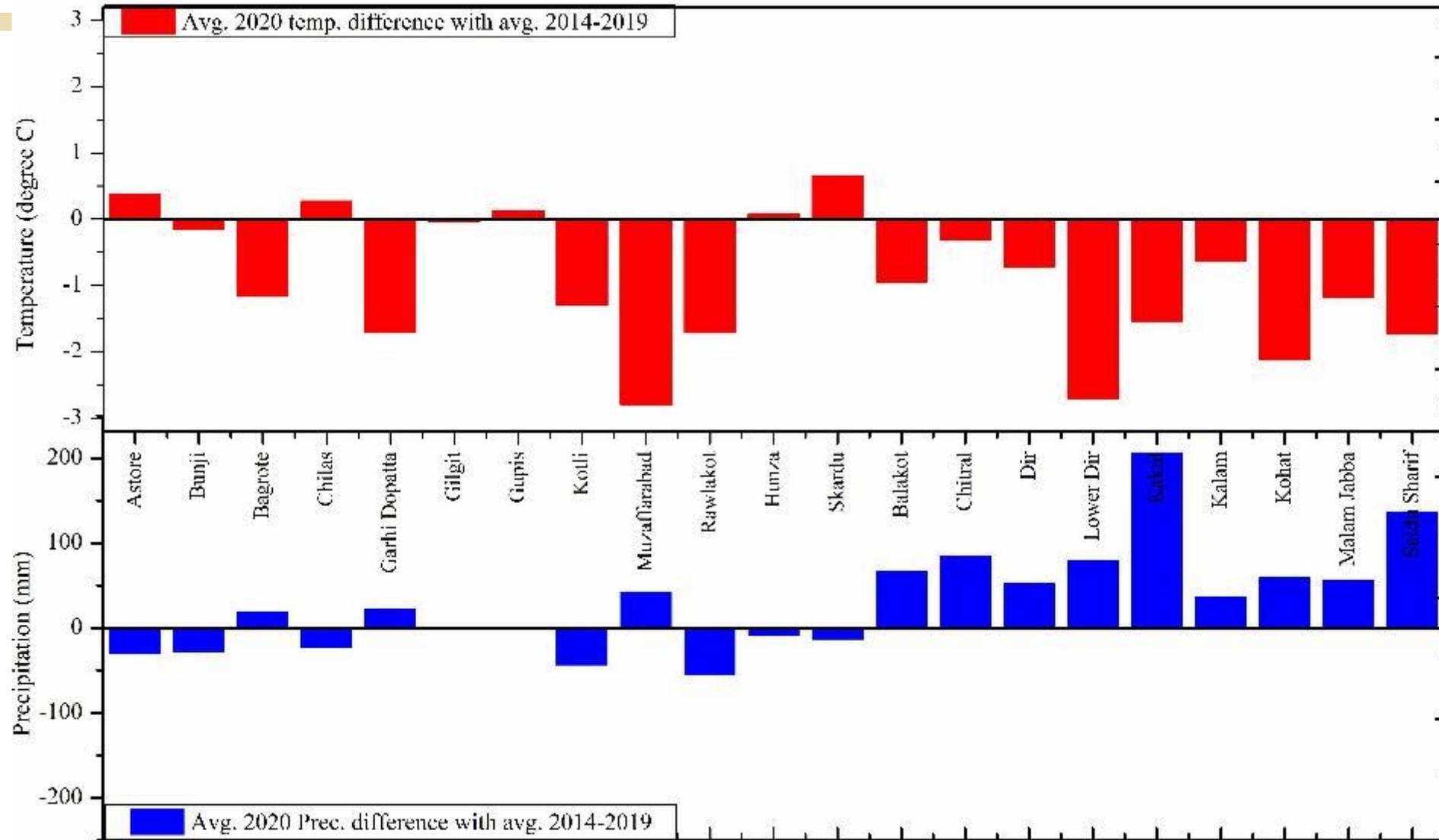


# Winter snow anomaly and agriculture production



Muhammad et al, in review

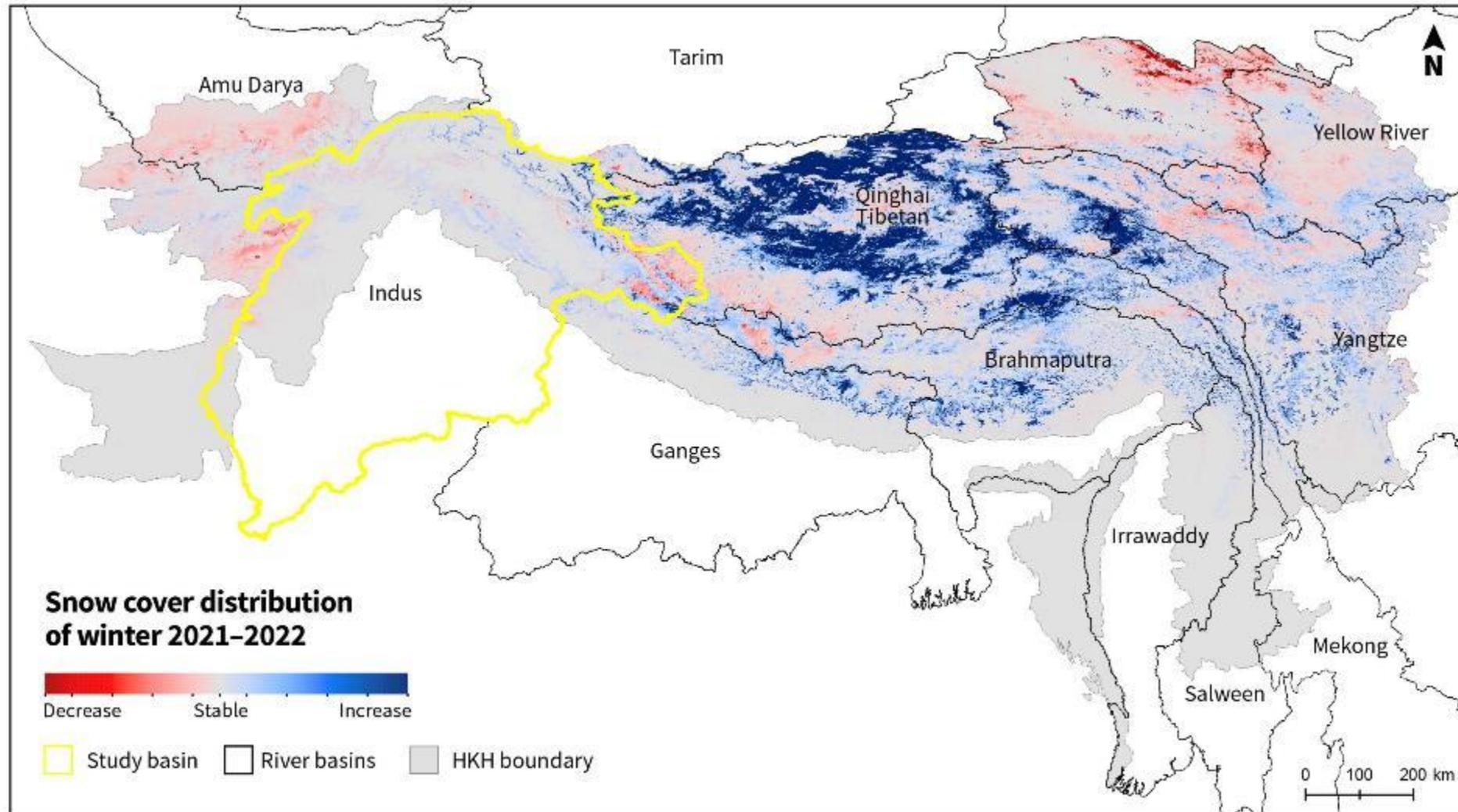
# Changes in temp and Precipitation



Reported ground information		Village (district)				
		Gulmit (Nagar)	Baramas (Juglote)	Tarashing (Astore)	Chakarkote (Gilgit)	Roundu (Skardu)
Altitude (meter above sea level)		2,400	1,500	2,200	2,300	2,200
Cropping zone*		Single	Double	Marginal double	Marginal double	Marginal double
Main crop(s) being cultivated during April and May		Potato & vegetables	Wheat & vegetables	Potato	Maize	Wheat, maize & millets
Contribution of local food production in annual food consumption (%)		41-60	21-40	41-60	≈20	41-60
Local Perception of average snowfall in the last winter (Nov 2019 – April 2020)		↑	↑	↑	↑	↑
Ending time of winter in 2020		▼	▼	■	■	●
Local people's perception of current situation (16 April - 31 May in 2020) compared with the average situation in same period during last 5 years	Average temperature	↓	↓	↓	●	↓
	Snow and glacier melting rate	↓	↓	↓	↓	↓
	Melting of snow from agricultural fields	▼	▼	■	●	▼
	Melting of snow from pastures	▼	▼	■	■	▼
	Water availability in streams largely fed by melt water	↓	↓	■	↓	↓
	Water availability in traditional irrigation systems ( <i>kuhls</i> ) fed by melt water	↓	↓	↓	■	●
	Overall water availability for crops	↓	↓	■	↓	↓
	Overall water availability for livestock	↓	↓	■	↓	↓

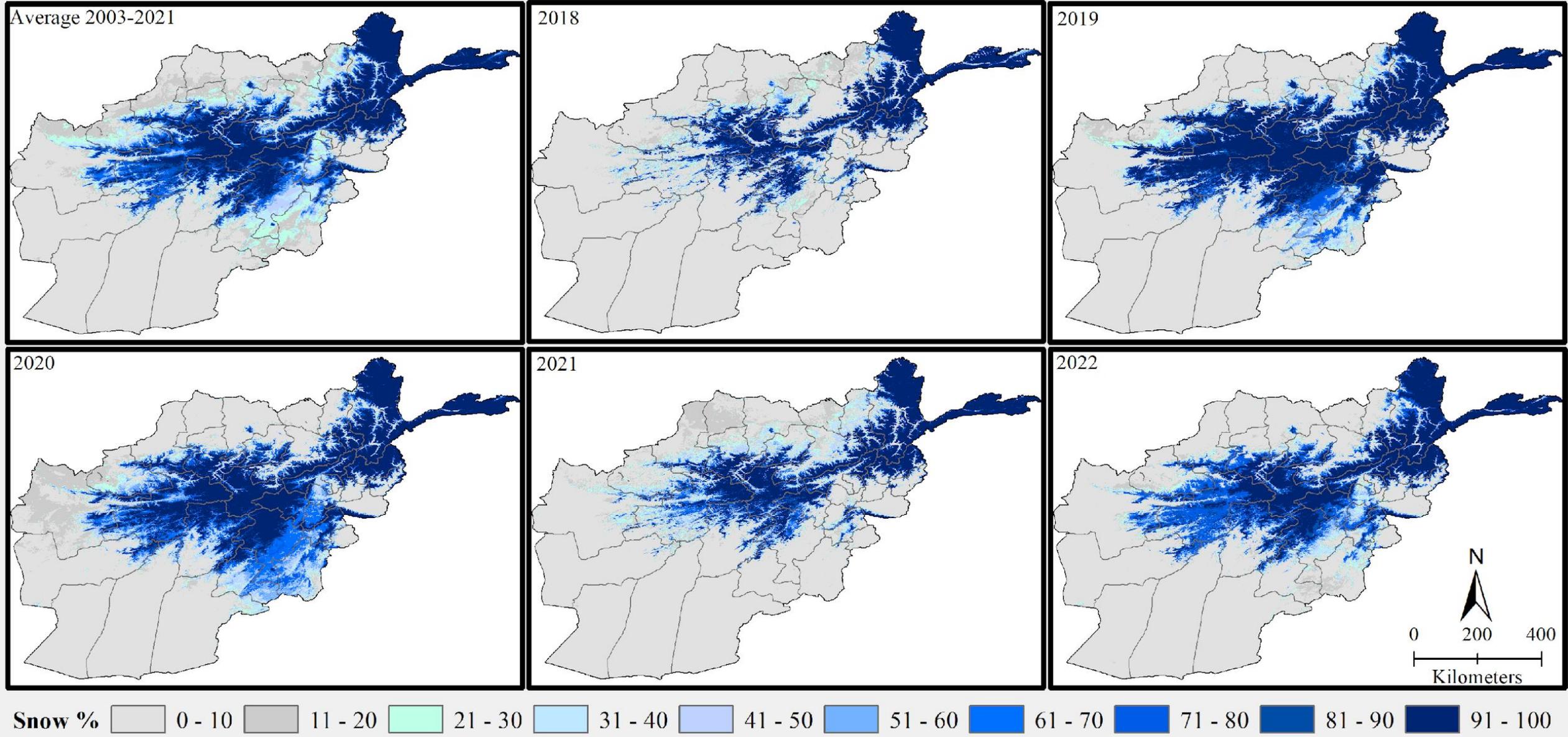
Increase = ↑; Decrease = ↓; No change = ■; Do not know = ●; Delayed = ▼

# 2022 snow change with normal in HKH

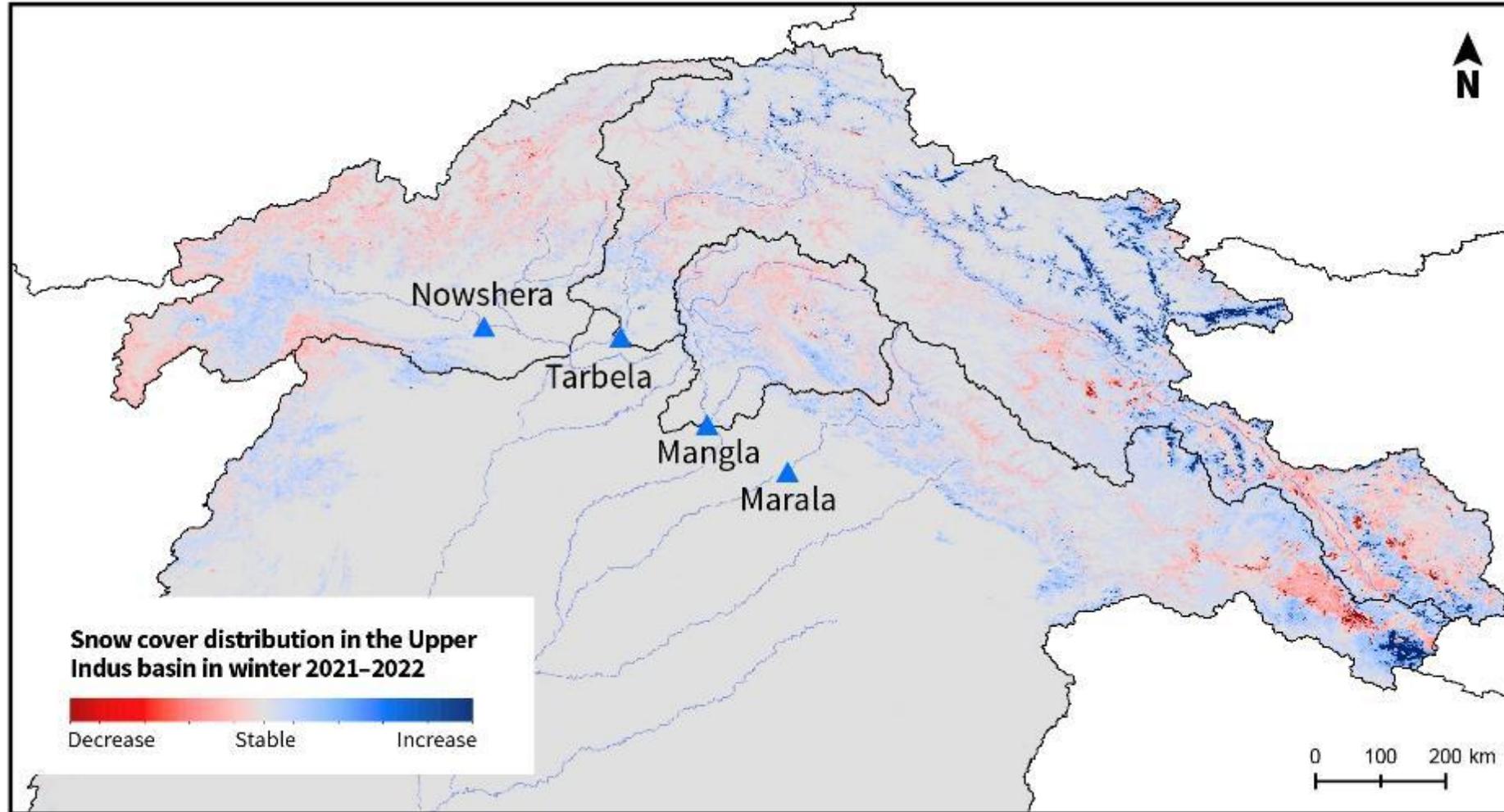


<https://servir.icimod.org/news/seasonal-water-outlook-and-implications-for-farmers-in-the-indus-basin/> (Faisal and Muhammad, 2022)

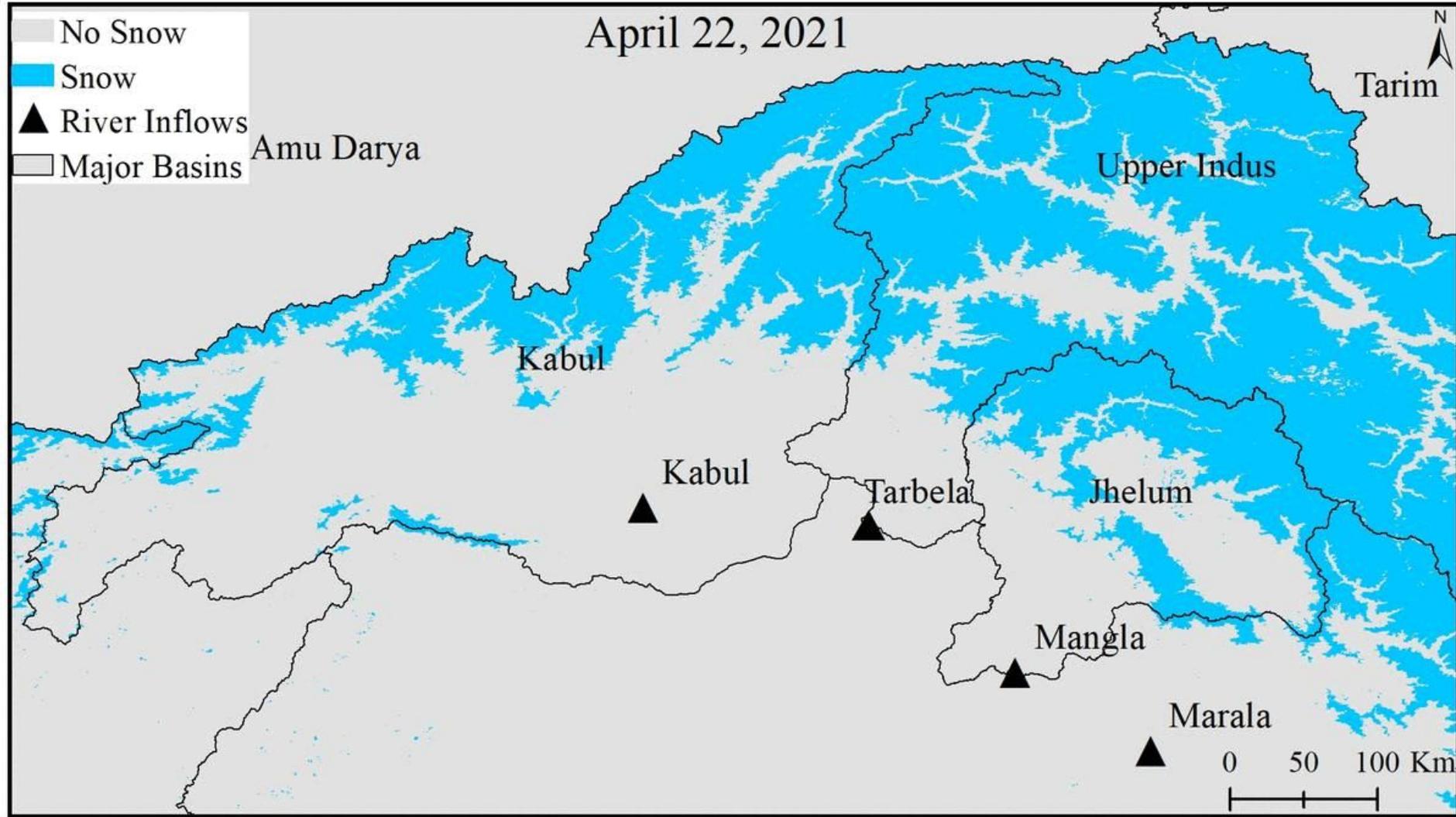
# Snow distribution pattern (January -



# 2022 snow change with normal in Indus



# Comparison of 2021 and 2022 snow



# Impact on river flow in the Indus

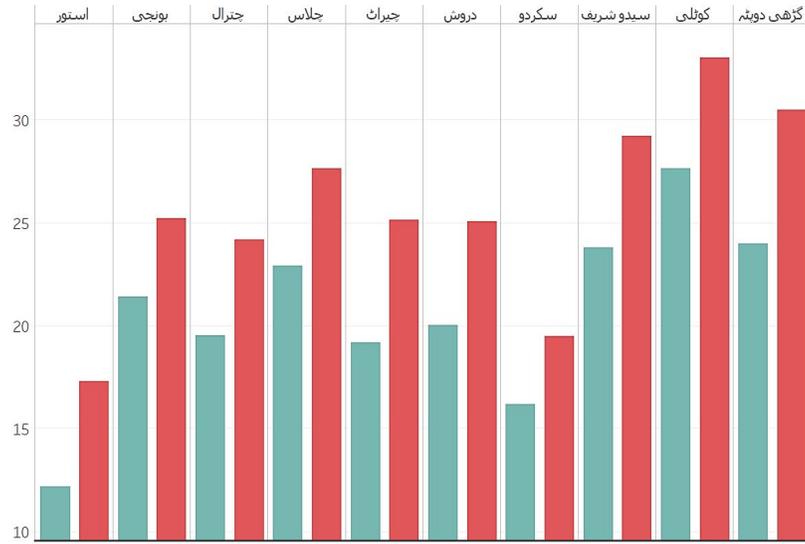


Figure: Comparison of temperature conditions from 01 March – 26 April during 2022 and long-term average at the high elevation snowy mountain regions in the upper Indus basin.

- Long-term average mean temperature
- 2022 mean temperature

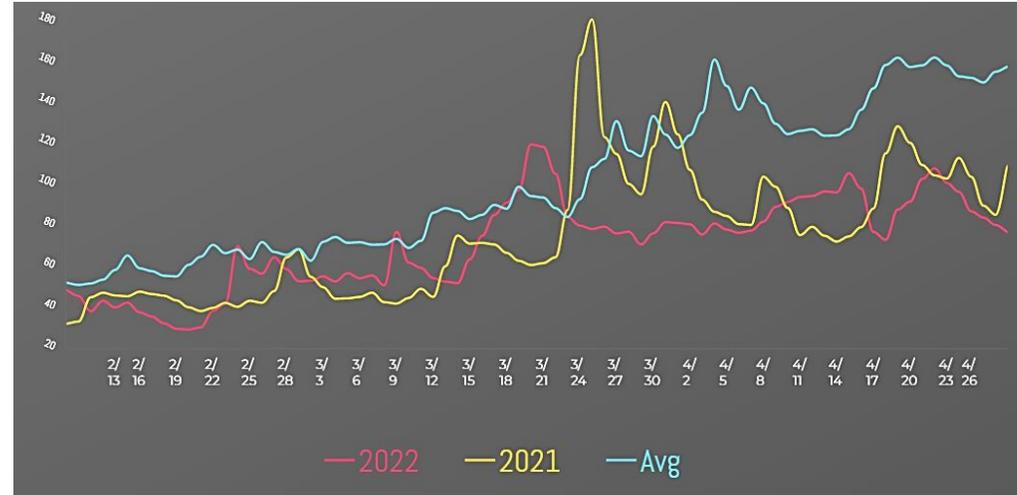


Figure: Inflow discharge pattern of the Indus Basin River System including Indus at Tarbela, Kabul at Nowshera, Jhelum at Mangla and Chenab at Marala during the early melting season.

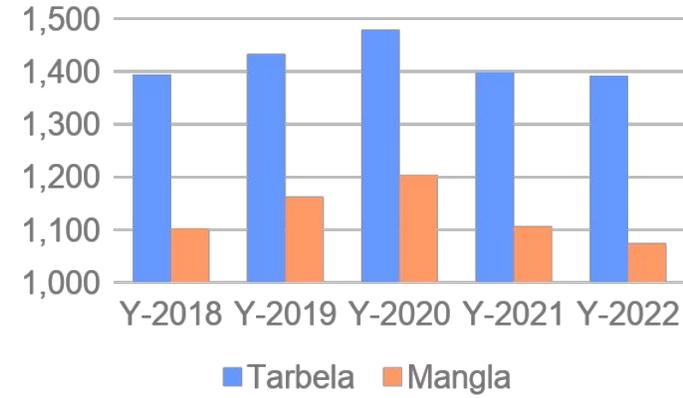
BBC NEWS | اردو

صفحہ اول پاکستان آس پاس ورلڈ کھیل فن فنکار سائنس ویڈیو

## تربیلا اور منگلا ڈیموں میں پانی کی کمی: کیا پاکستان کو اب ہر سال ایسی صورت حال کا سامنا ہو گا؟

محمد زبیر خان  
صحافی

29 مئی 2022



Reservoir levels on 28<sup>th</sup> April from 2018 - 2022

Seasonal water outlook and implications for farmers in the Indus basin

FAISAL MUEEN QAMAR AND SHER MUHAMMAD

8 MINS READ





Sher Muhammad @Dr\_MSher · May 4

#ALERT Our assessment of the ice-dammed lake due to #Shisper glacier #surge indicate that the lake may outburst anytime as the extent of the lake is at #peak since the last #outburst.



Sher Muhammad @Dr\_MSher · May 7

#Update Shisper lake is reportedly #outburst

ICIMOD @icimod · May 4

This GIF shows recent expansion of the ice-dammed lake created by the surge in #ShisperGlacier. Researchers estimate this expansion is close to the extent before the past outburst.

This blog highlights the impacts of 2021 dam breach  
[icimod.org/article/gender...](https://icimod.org/article/gender...)  
 #CryosphereWednesday

PAMIR TIMES @pamirtimes · May 7

Glacial lake outburst flood in #Hunza damages bridge, #KKH and threatens Hassanabad settlement  
 #GlobalWarming #ClimateChange #GLOF



BBC NEWS | اردو

صفحة اول پاکستان آس پاس ورلڈ کھیل فن فنکار سائنس ویڈیو

گلگت بلتستان: شیشپر گلیشیر پر بننے والی جھیل پھٹنے سے سیلابی صورتحال، حسن آباد پل ٹوٹ گیا، شاہراہ قراقرم ٹریفک کے لیے بند

محمد زبیر خان  
صحافی

6 مئی 2022

اپ ڈیٹ کی گئی 7 مئی 2022

Title: As Himalayan Glaciers Melt, a Water Crisis Looms in South Asia

<https://e360.yale.edu/features/himalayas-glaciers-climate-change>

- **Timely snow** accumulation and melt are crucial for downstream water resources
- **Continuous cryosphere monitoring** is the key to managing water resources and coping with **related hazards**
- **Multi-disciplinary** cryosphere research is significant to understand the potential impacts
- **Coordinated** and connected research with **stakeholders** is crucial
- Strengthening Science to policy communications

# Acknowledgments



**NORWEGIAN MINISTRY  
OF FOREIGN AFFAIRS**



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

**Swiss Agency for Development  
and Cooperation SDC**

# Thank you



Aga Khan Agency for Habitat



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LOSS PREVENTION CENTRE FOR ASIA



ADAPTATION FUND