

Melting glaciers and rising cryospheric hazards in the Himalayas

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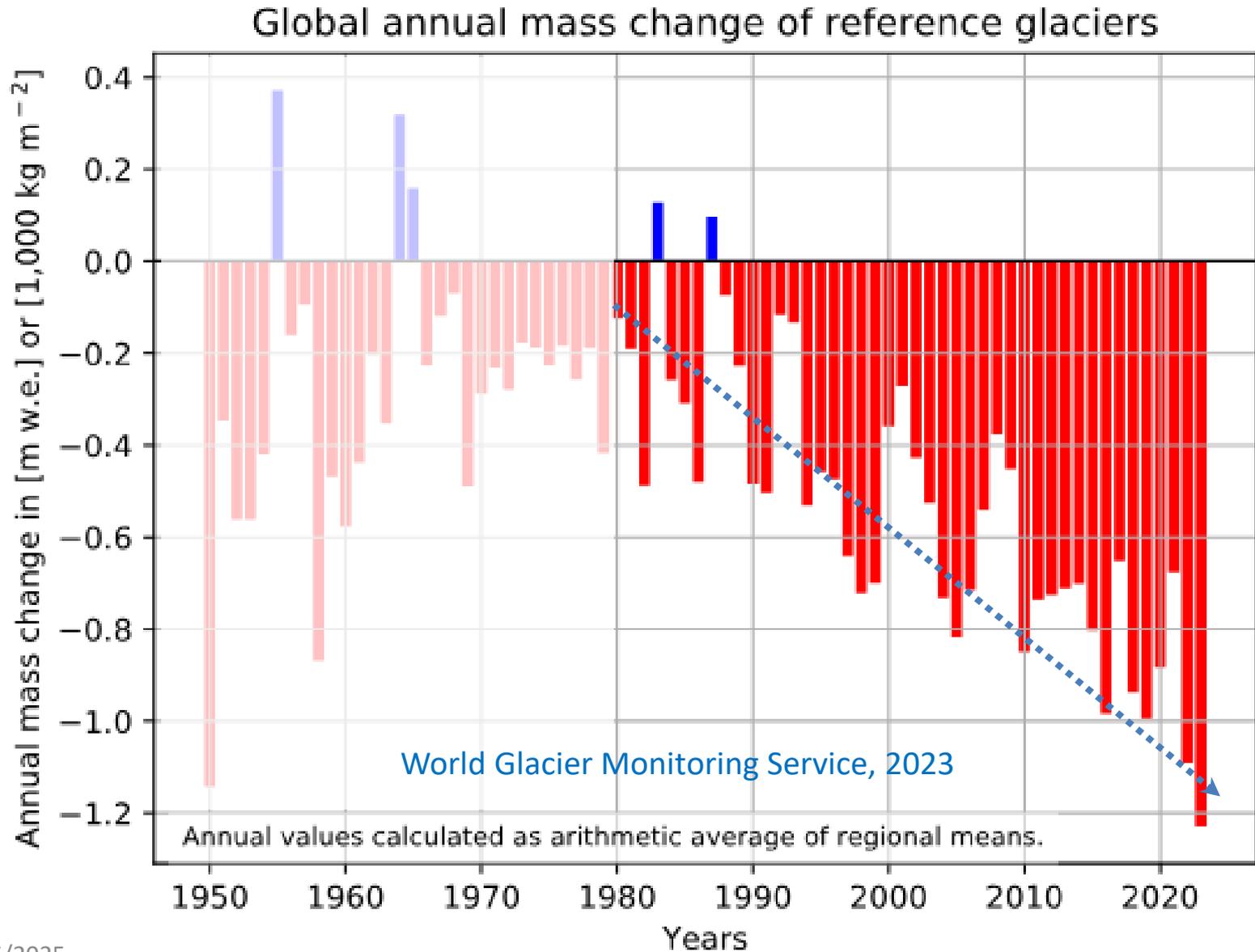
SSG Member, WCRP-CLIC



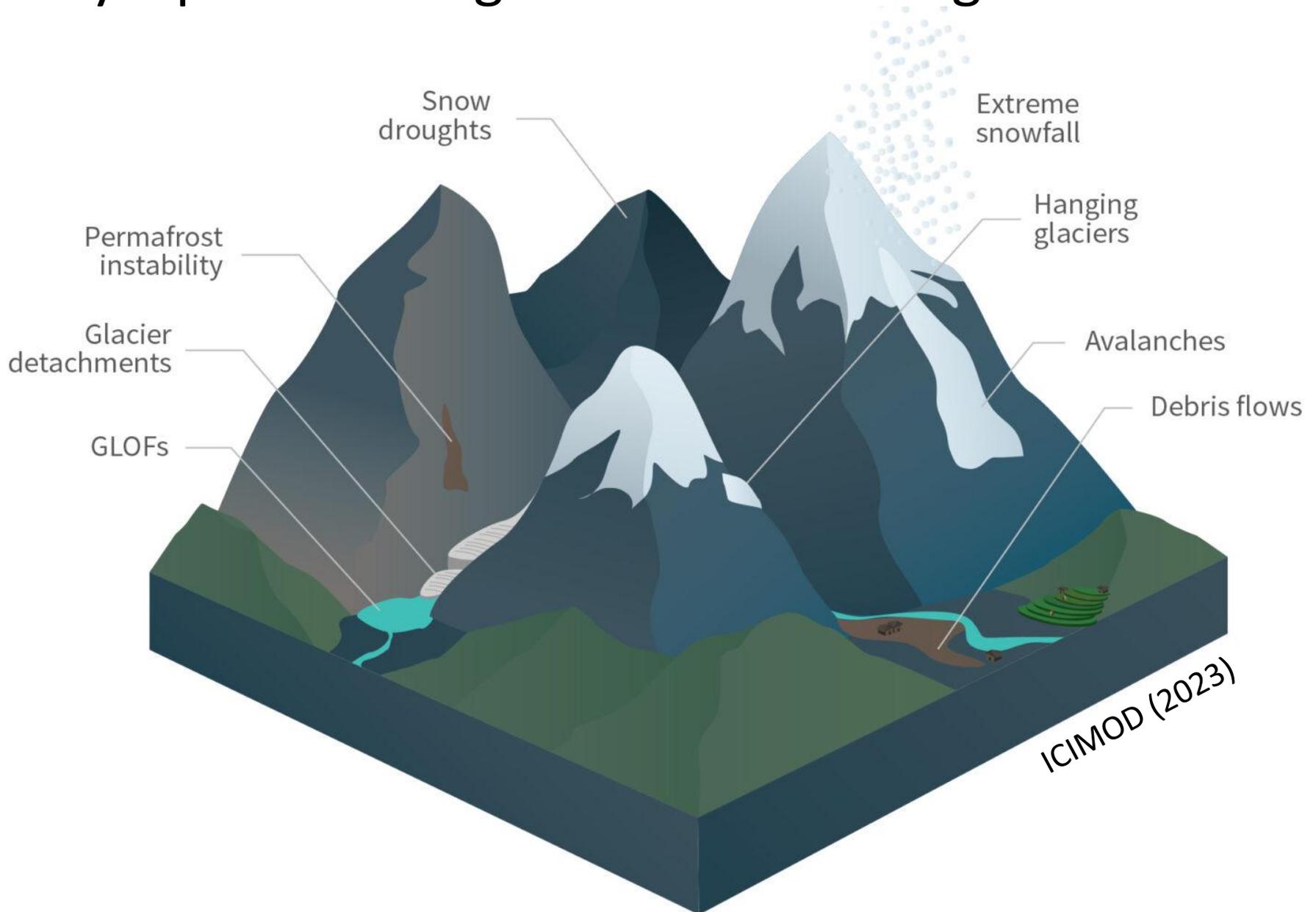
National Centre for Polar and Ocean Research
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Indian Gateway to the Polar Regions

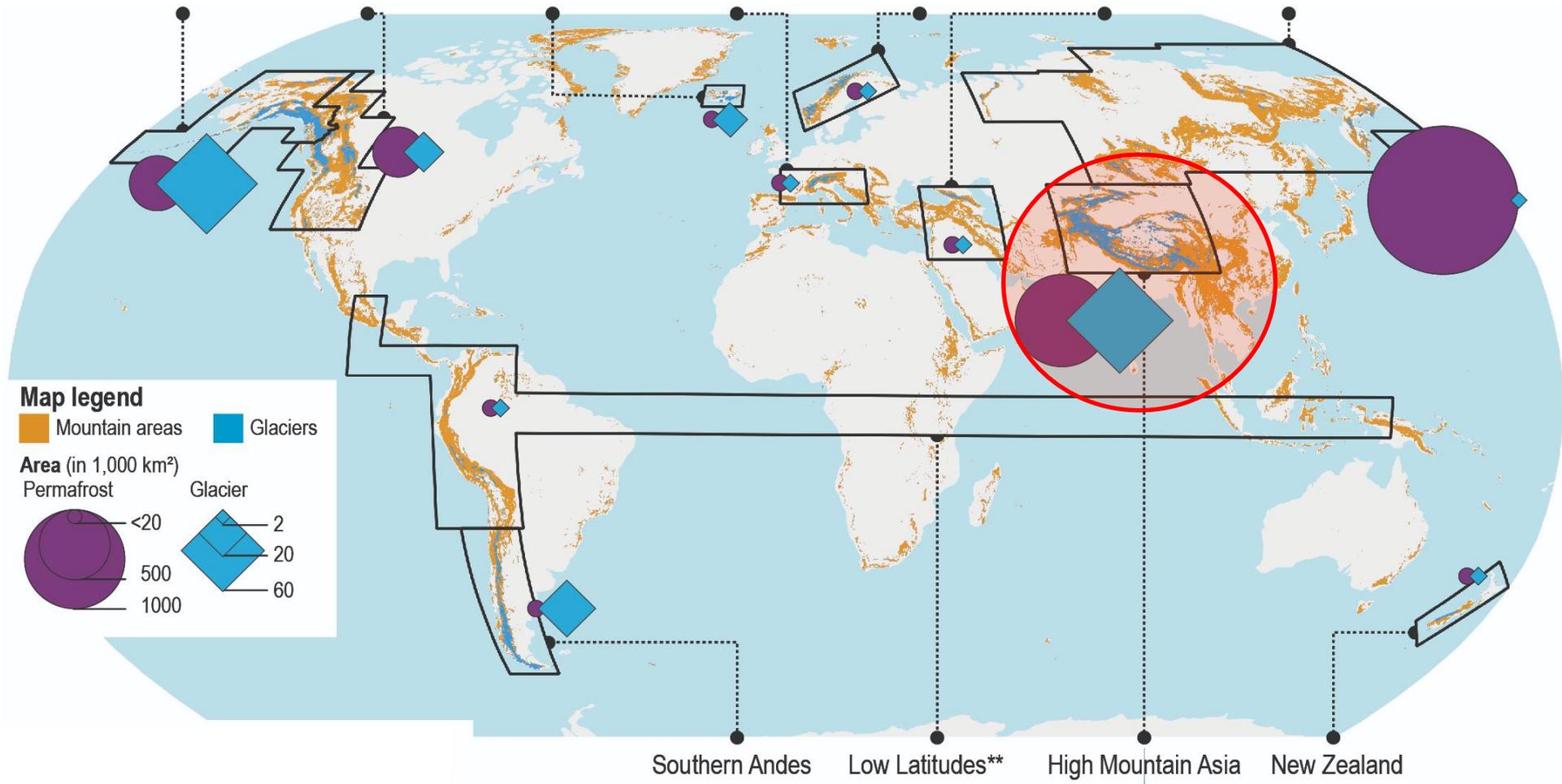
Changing climate and thinning mountain glaciers



Cryospheric changes & hazards in high mountains



Mountain cryosphere - Critical for water resources, energy and economy with immediate societal impact

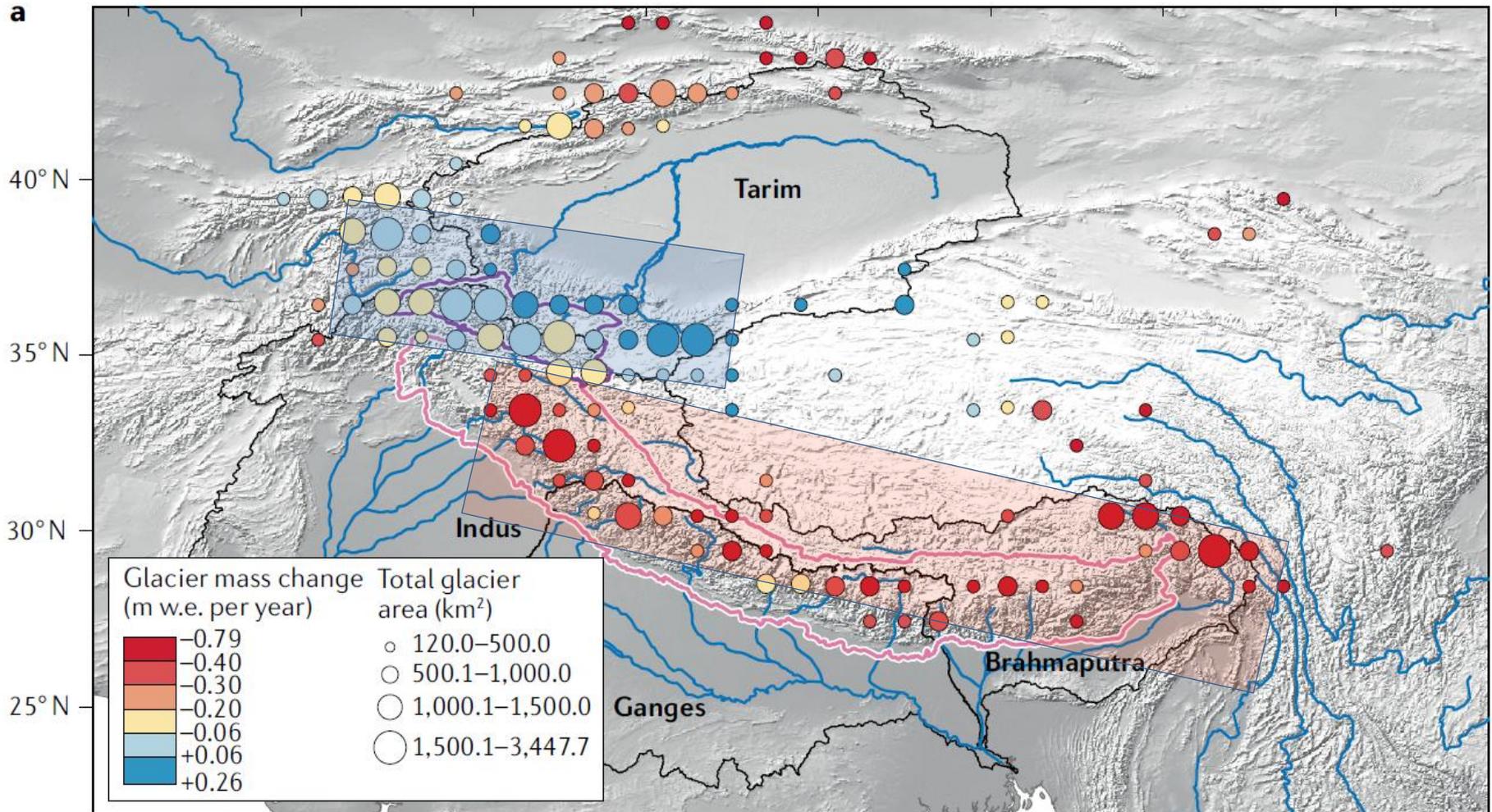


Hock et al., 2019, In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate

Critical importance of Himalayan cryosphere

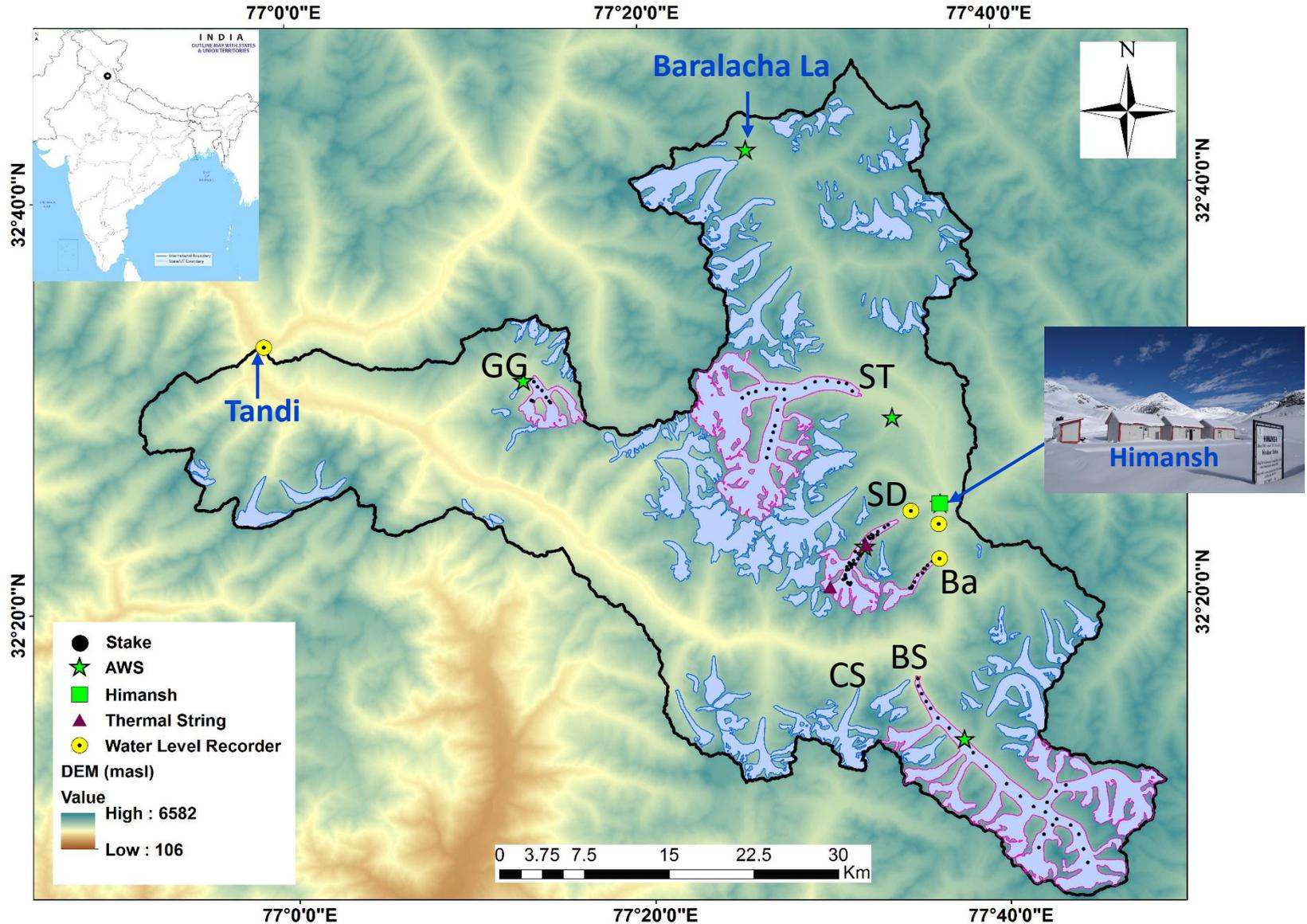
- Key for sustainability, economy, energy needs of South Asia
- Feeds to ten major rivers that supports nearly 1.9 billion people
- Plays a vital role in global weather and climate, and most importantly Asian Monsoon system.
- Thawing Himalaya has strong impact on downstream environment, water availability, human health and sustainable development of South Asia and its people
- The defrosting of Himalayas also affect the stability of slopes, increased incidence of floods due to glacier lake outburst or rain-on-snow, landslides and snow avalanches
- Deterioration of Himalayan environment and ecology is a major concern

H-K glacier mass balance and area change (2000 – 2016)

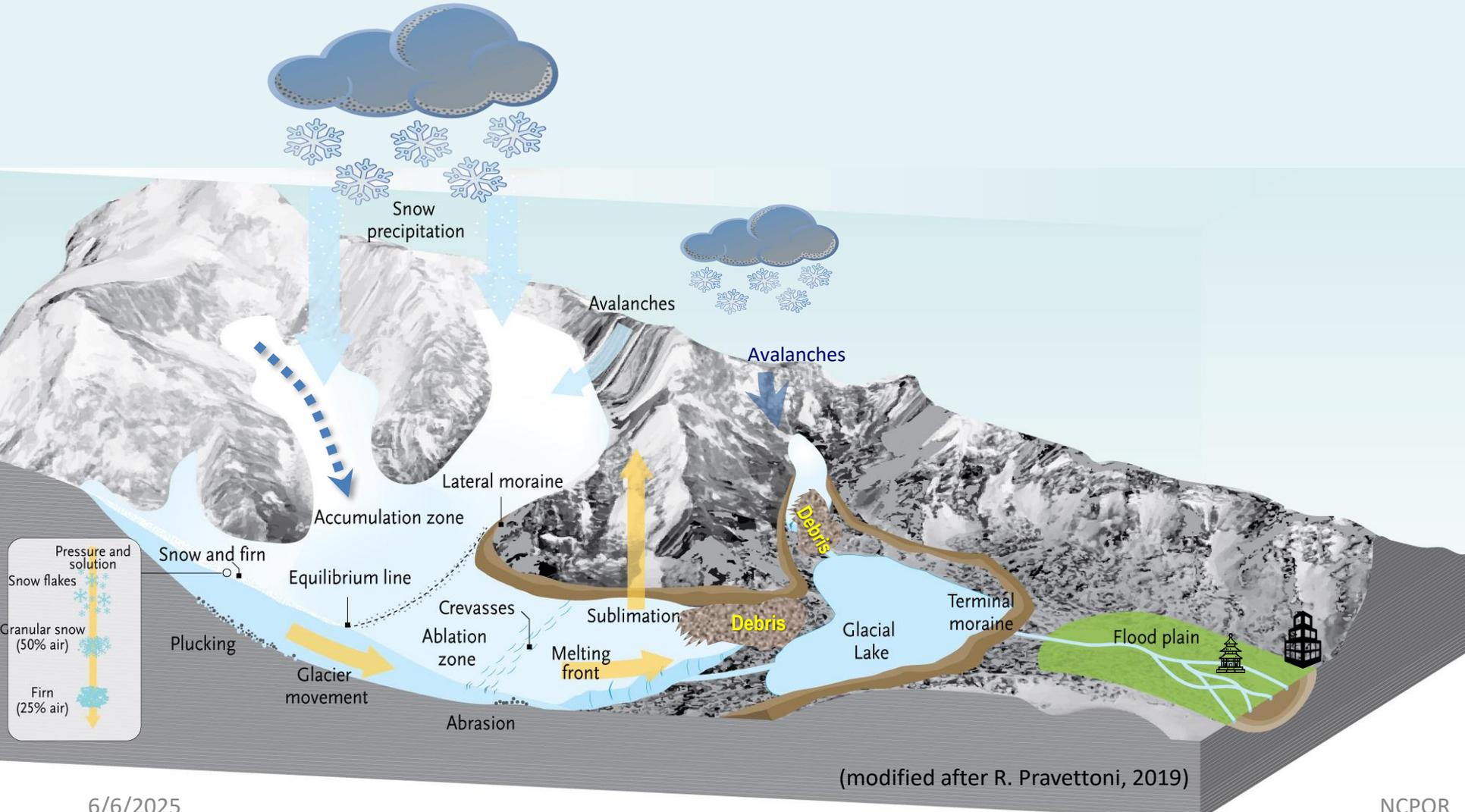


Nie et al., 2021, *Nat. Rev. Earth. Environ.*

Glacier mass balance and climate sensitivity – case study from Chandra Basin (Western Himalaya)

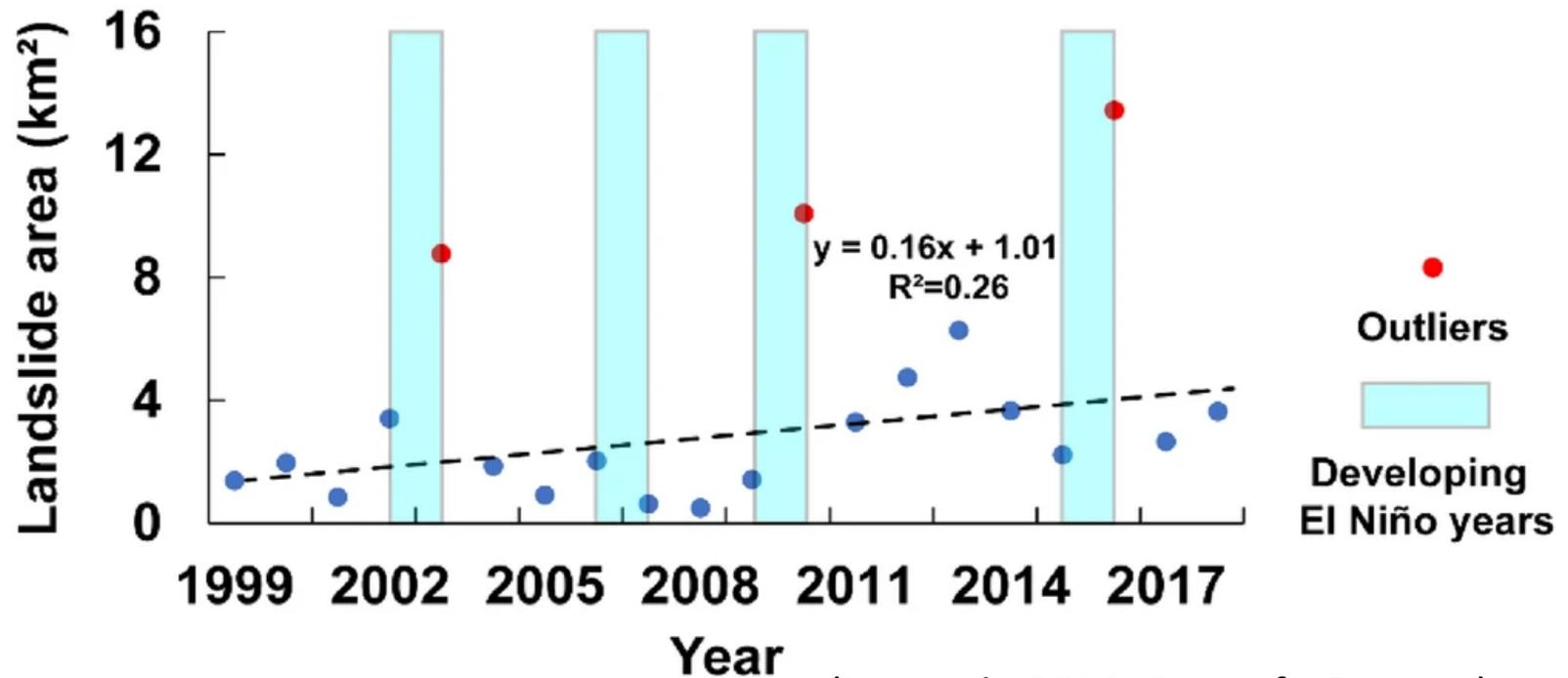


Cryospheric hazards are snowballing in Himalaya with enhanced warming



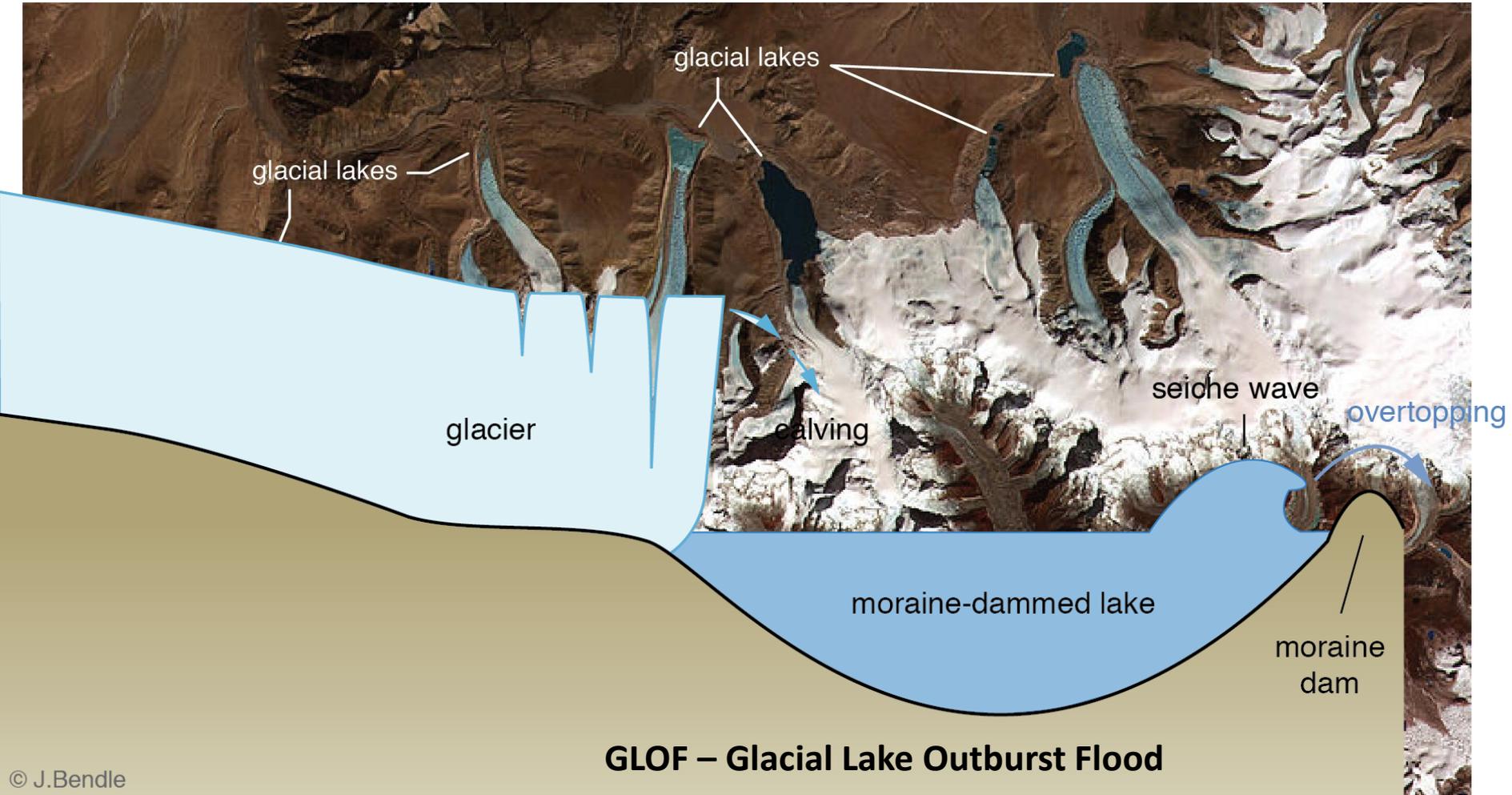
(modified after R. Pravettoni, 2019)

Studies indicate that retreat of glaciers in the High Mountain Asia for the last two decades was associated with more frequent and larger landslides



(Liu et al., 2021, Scientific Reports)

Melting glaciers create proglacial lakes that keep expanding as glaciers retreat

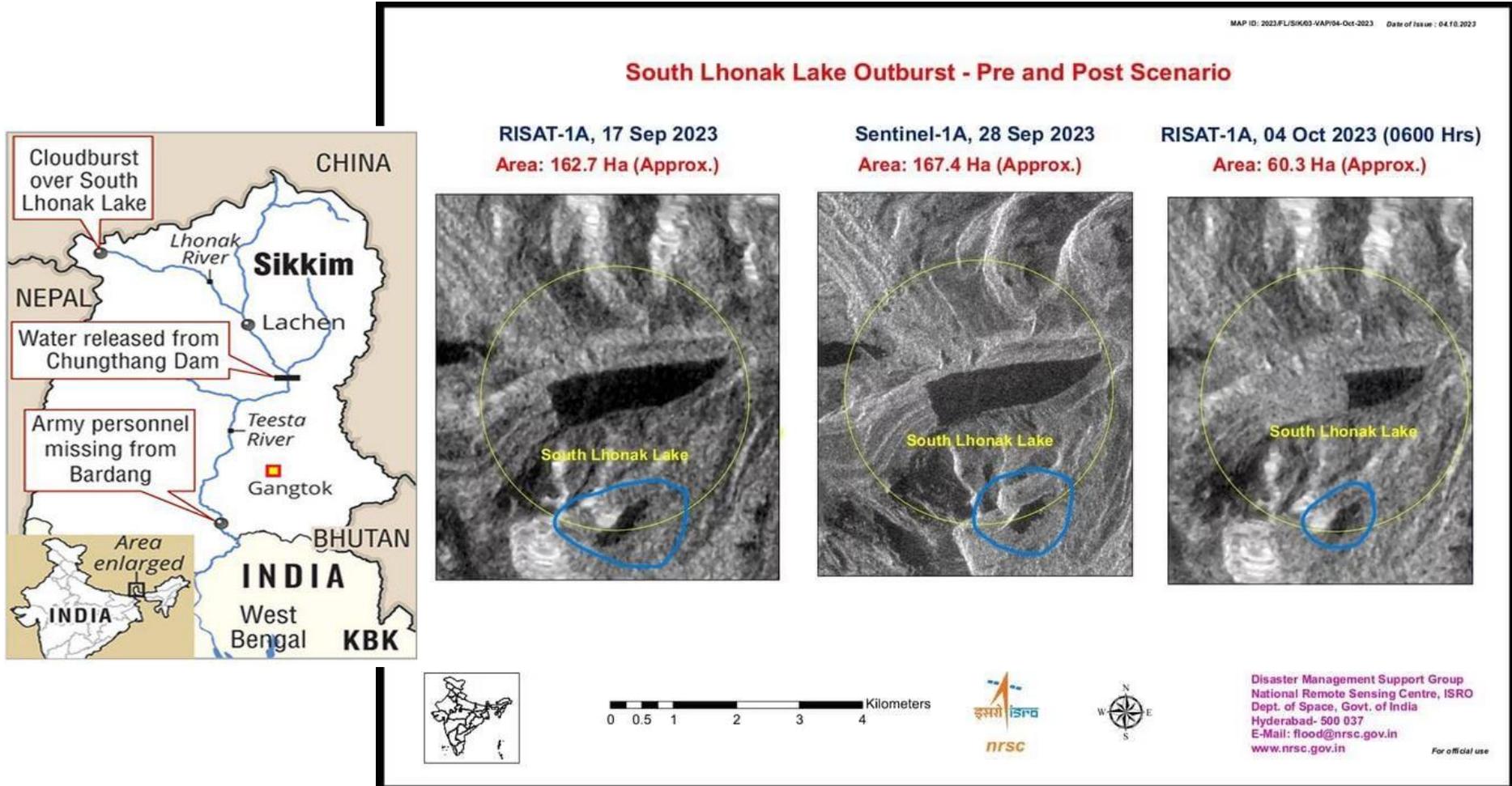


Expanding proglacial lakes as potential hazards

- The Himalayas host more than 5,000 glacial lakes, most of which are proglacial in nature
- Studies show that such lakes have increased ~47% by number, 33% by area and 42% by volume from 2000 to 2020 (Zhang et al., 2023)
- Most rapid lake expansion is found in Central Himalayas, where downstream areas are also heavily populated, making the region very vulnerable to GLOFs
- Importantly, studies indicate that there could be significant mass-loss underestimation of lake-terminating glaciers due to poor constraints on the subaqueous mass loss...

Sikkim (South Lhonak Lake) GLOF

– a disaster that was in waiting for a decade –



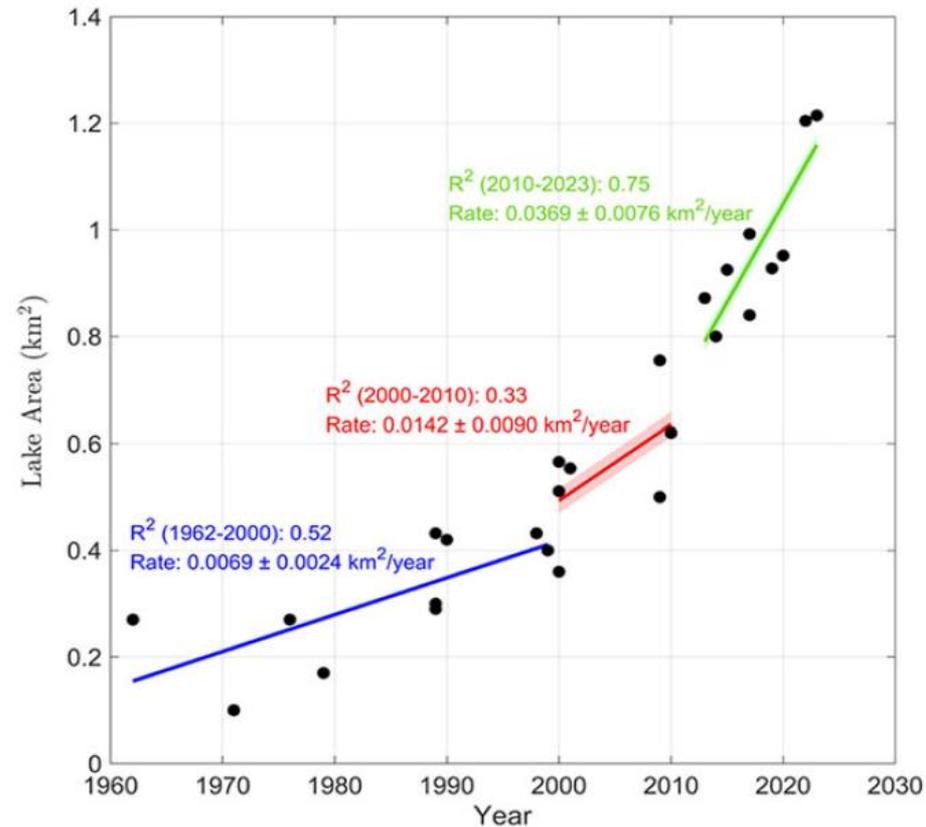
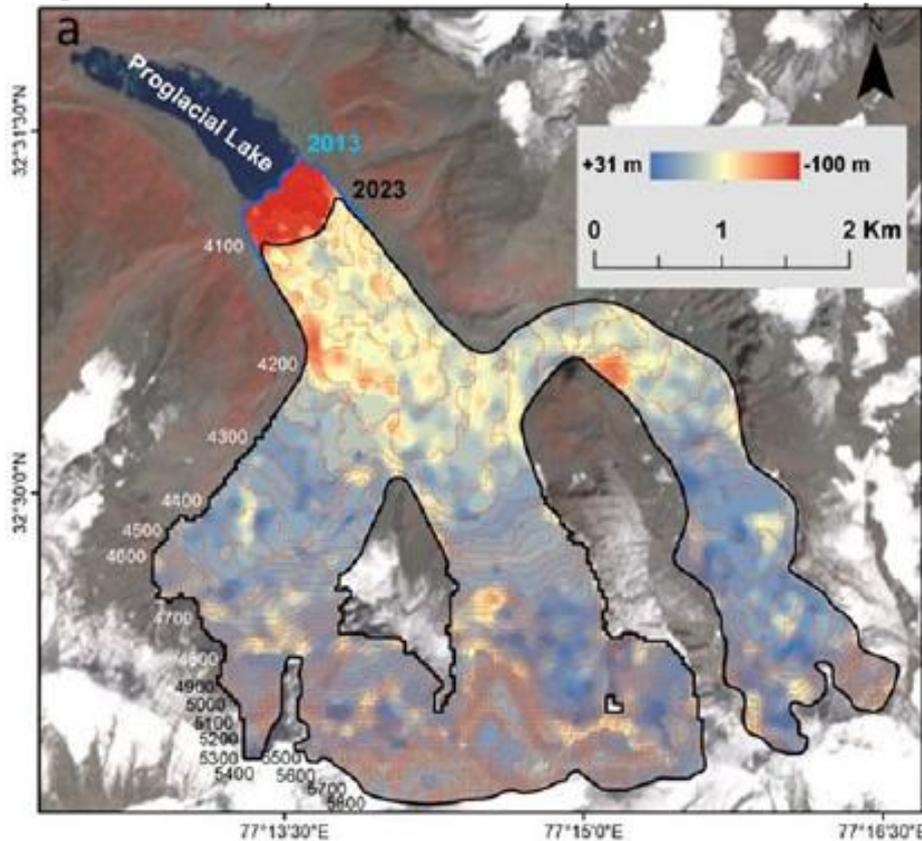
Mass balance of lake terminating Gepang Gath glacier (western Himalaya, India) and the role of glacier–lake interactions

Article

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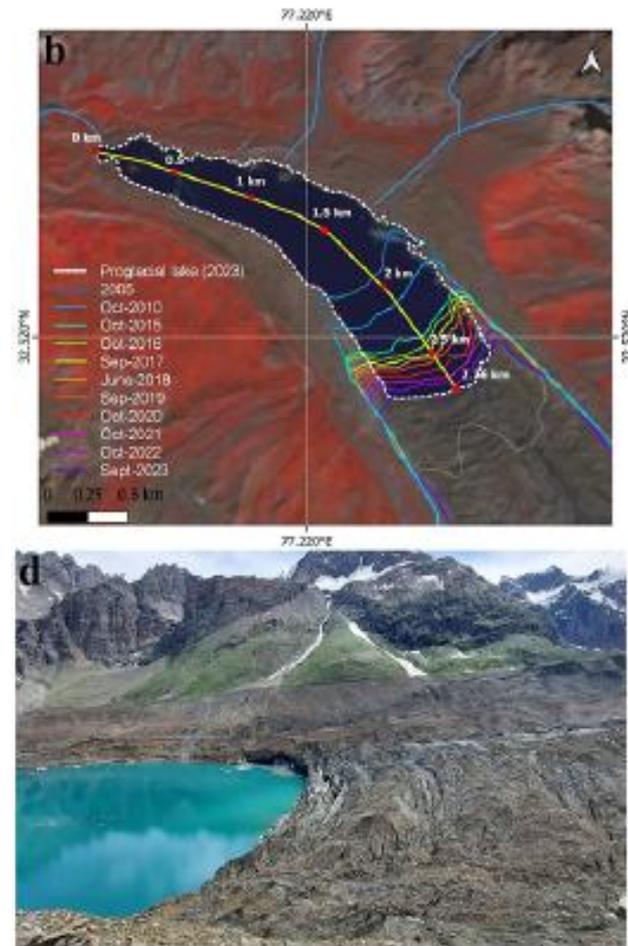
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Proglacial lakes and glaciers have a codependent and compounding effect on mass loss and lake expansion

- Study revealed that the GG proglacial lake expanded from 0.20 to 1.21 km² between 1962 and 2023, showing a nearly six fold growth; This expansion is linear with time & an accelerated expansion after 2010.
- Overall, the yearly frontal ice loss exacerbates the mass loss by 17–22%.
- Study demonstrated a codependent and compounding effect of the proglacial lake in exacerbating the overall ice mass loss faced by the Gepang Gath glacier and vice versa.
- These findings suggest that the presence of proglacial lakes plays a significant role in intensifying ice mass loss from Himalayan glaciers.
- Such cases call for monitoring at a high spatiotemporal scale and establishment of an early warning system for potential cryospheric hazards like GLOF



Pratap et al., 2025, *J. Glaciology*

Bridging gap between research and service

- Considering the regional and site-specific nature of extreme weather events and associated geo-hazards like GLOF, avalanches, landslides, flash floods in the poles, a combination of in situ data, high-res satellite data and modelling needed for predicting cryospheric hazards.
- However, current and emerging risks in cryosphere regions require a “research to services” approach.
- Needs international and regional collaborations
- WMO’s EC Panel on Polar and High-mountain Observations Research and Services (PHORS) aims to bridge the gap and bring partnerships
- WMO (World Meteorological Organization) has initiated new networks to support polar climate and cryosphere observations & services
 - Arctic Regional Climate Centre Network (ArcRCC-Network) – Running successfully
 - Third Pole Regional Climate Centre Network (TPRCC-Network) – Demo phase
 - Antarctic Regional Climate Centre Network (AntRCC-Network) – Framework phase
- The WCRP-CliC (Climate and Cryosphere) core project is starting a new activity - Impacts of changes in the mountain cryosphere (IC-MONTC).

Cryosphere High Level Ambitions (WMO EC-78 [2024])

1. Everyone on the planet is prepared for and resilient to the impacts from changes in the cryosphere.
2. The global community works collaboratively to limit and reduce cryosphere loss and its impacts.
3. Data, science, and indigenous knowledge are accessible and provide a sound basis for policies and decisions relating to the cryosphere.
4. The importance of the cryosphere and the consequences of its changes are known, universally understood and inspire action.

- ❖ United Nations adopted a resolution to establish the “Decade of Action for Cryospheric Sciences, 2025–2034”
- ❖ 2025 is International Year of Glaciers' Preservation



2025
International
Year of Glaciers'
Preservation



NCPOR

Indian Gateway to the Polar Regions



Bharati - Antarctica



Maitri - Antarctica



Himadri - Arctic



Himansh - Himalaya

