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TECHNICAL REPORT

HKH Glacier Outlook 2026: Insights from 50 Years of Himalayan Glacier Monitoring

Mohd. Farooq Azam

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Sunipa Das Gupta/ICIMOD

Layout
Sudip Kumar Maharjan/ICIMOD

Photos
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For further information, please contact:
info@icimod.org

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Author
Mohd. Farooq Azam

Photo: Patrick Wangon

Preface

The glaciers of the Hindu Kush Himalaya (HKH) are among the most visible and sensitive indicators of climate change in our region. They nourish the great river systems of Asia, sustain ecosystems and economies, and underpin the water, food, and energy security of nearly two billion people, whose future is inseparable from the future of the HKH glaciers.

This HKH Glacier Update marks fifty years since the first systematic glacier-wide mass balance measurements were conducted in the Himalaya. Over these five decades, dedicated scientific efforts have generated invaluable evidence on how our glaciers are responding to a changing climate. At a time when 2025 has been declared the International Year of Glaciers' Preservation,marking the beginning of the Decade of Action for Cryosphere Science (2025-2034), this milestone document offers both reflection and resolve.

The findings underscore the urgency of strengthening long-term glacier monitoring as essential climate infrastructure. Sustained regional cooperation, investment in observation networks, and shared data systems will be critical to improving hydrological forecasting, reducing disaster risk, and informing climate-resilient development pathways. Protecting the HKH cryosphere is not only a scientific responsibility — it is a collective regional imperative.

Photo: Patrick Wangon

Introduction

The glaciers of the HKH are among the world's most critical high-mountain water reserves, sustaining mighty Asian river systems, such as Indus, Ganga and Brahmaputra, that support a billion plus people downstream. These glaciers regulate seasonal water availability, buffer drought conditions, influence hydropower generation, and shape the resilience of downstream agriculture and economies. As global and regional temperatures continue to rise, the future of these glaciers has become a defining issue for regional water security, disaster risk reduction, and climate adaptation.

Over the past decades, scientific monitoring has revealed a clear and accelerating transformation of HKH glaciers. Many glaciers are losing mass at increasing rates, altering runoff patterns and contributing to the expansion of glacial lakes, with implications for Glacial Lake Outburst Flood (GLOF) risk and long-term water supply stability. While some sub-regions, like the Karakoram, exhibit complex behaviour, the overall trajectory points towards sustained glacier shrinkage under current warming pathways. These changes are already influencing seasonal water availability, hydropower reliability, and mountain livelihoods, underscoring the urgency of coordinated monitoring and policy action among regional member countries.

The first glacier-wide field measurements were conducted 50 years ago, in June 1974, on Gara glacier in Himachal Pradesh (western Himalaya, India) by the Geological Survey of India, laying the foundation for understanding glacier–climate interactions. Subsequent decades saw expansion in field monitoring through national programmes and international collaborations, followed by a major leap in the early 2000s coupled with the emergence of satellite remote sensing that enabled regional-scale assessments of glacier change. Despite this progress, field monitoring coverage remains limited. As to date only 38 glaciers have been observed out of approximately 63,700 glaciers in the HKH region. Furthermore, these observations are unevenly distributed across the HKH, highlighting the need for sustained investment and coordinated regional strategies.

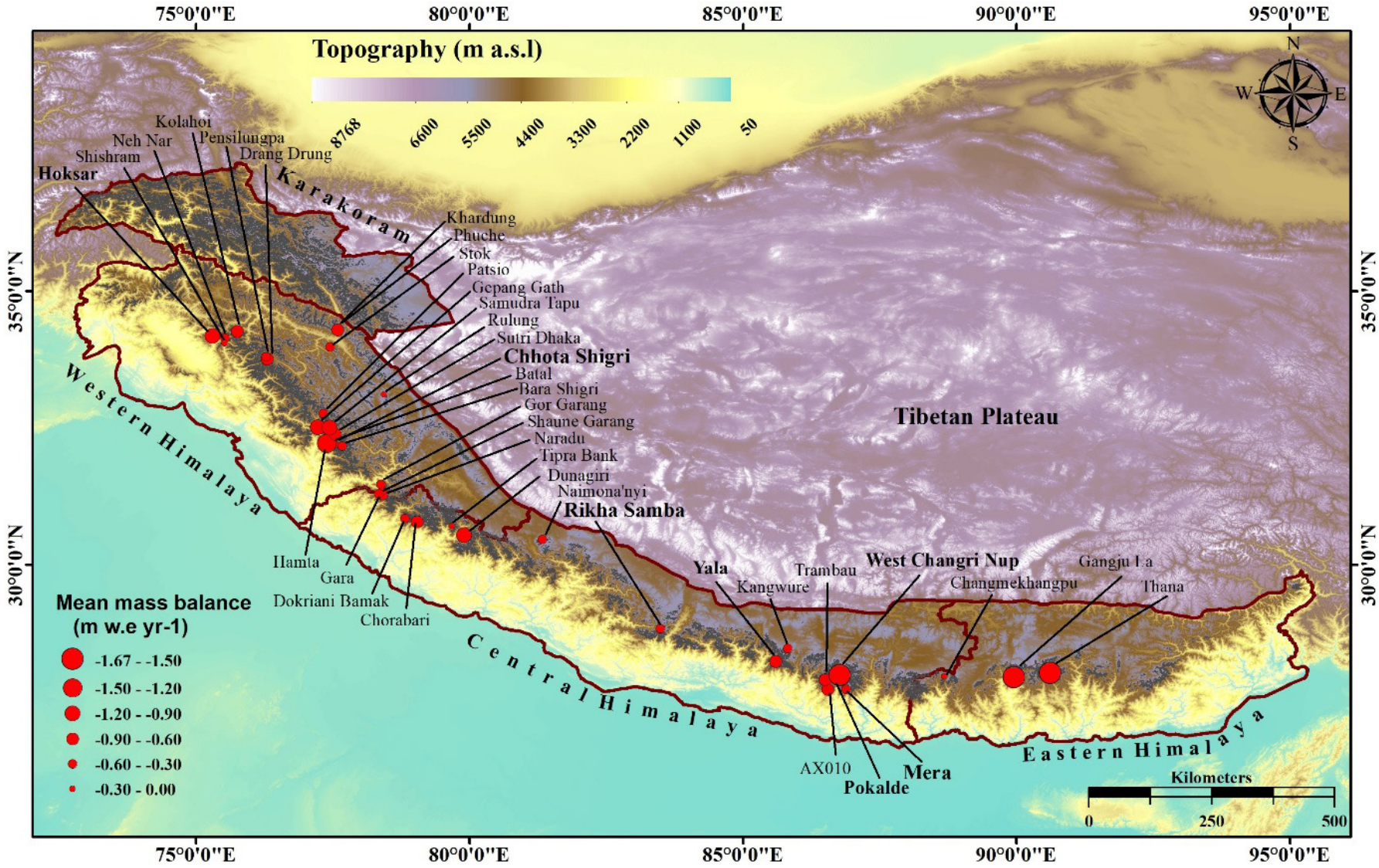
With 2025 declared as the International Year of Glaciers' Preservation (IYGP), glacier change is elevated from a scientific concern to a global policy priority. This convergence of scientific legacy and international recognition offers a unique opportunity to strengthen regional cooperation, modernise observation systems, and align investments with long-term climate resilience goals. In current scenario, sustained long-term glacier monitoring is not merely a scientific requirement — it is the foundational base for climate risk management, transboundary water cooperation, and sustainable mountain development.

This report builds upon five decades of field monitoring of Himalayan glaciers to present an updated overview of glacier status, monitoring achievements, and priority actions. It aims to inform ministers, development partners, and regional institutions about the evidence base underpinning glacier change and to highlight where coordinated support is most urgently needed. As the world and the HKH enters the Decade of Action for Cryosphere Science (2025–2034), translating scientific knowledge into sustained action will be essential to safeguard glaciers and the communities that depend upon them.

Glacier mass wastage and trends in the Himalaya since 1974

A total of 302 annual observations of glacier–wide mass balances have been recorded from 38 glaciers since September 1974, comprising 32 positive mass balance years (11%) and 270 negative mass balance years (89%) (Figure 1). Out of 38 glaciers, 17 mass balance series were discontinued (AX010, Changmekhangpu, Chorabari, Dokriani Bamak, Dunagiri, Kangwure, Gara, Gor Garang, Hamtah, Naimona'nyi, Neh Nar, Patsio, Rulung, Shaune Garang, Shishram, Stok and Tipra Bank glaciers) with a maximum observation period of circa 10-12 years for a few glaciers. Nineteen series remain continuous (Batal, Bara Shigri, Chhota Shigri, Drang Drung, Gangju La, Gepang Gath, Hoksar, Khardung, Mera, Pensilungpa, Phuche, Pokalde, Rikha Samba, Sutri Dhaka, Samudra Tapu, Thana, Trambau, West Changri Nup, Yala,), while two series (Kolahoi, and Naradu glaciers) have been reinitiated.

FIGURE 1: **THE LOCATION OF ALL 38 GLACIERS OBSERVED SINCE 1974 IN THE HIMALAYAN REGION. THE WGMS BENCHMARK GLACIERS (MERA, POKALDE, RIKHA SAMBA, WEST CHANGRI NUP, AND YALA GLACIERS IN THE CENTRAL HIMALAYA, NEPAL, AND CHHOTA SHIGRI AND HOKSAR GLACIERS IN THE WESTERN HIMALAYA, INDIA) ARE SHOWN IN BOLD.**

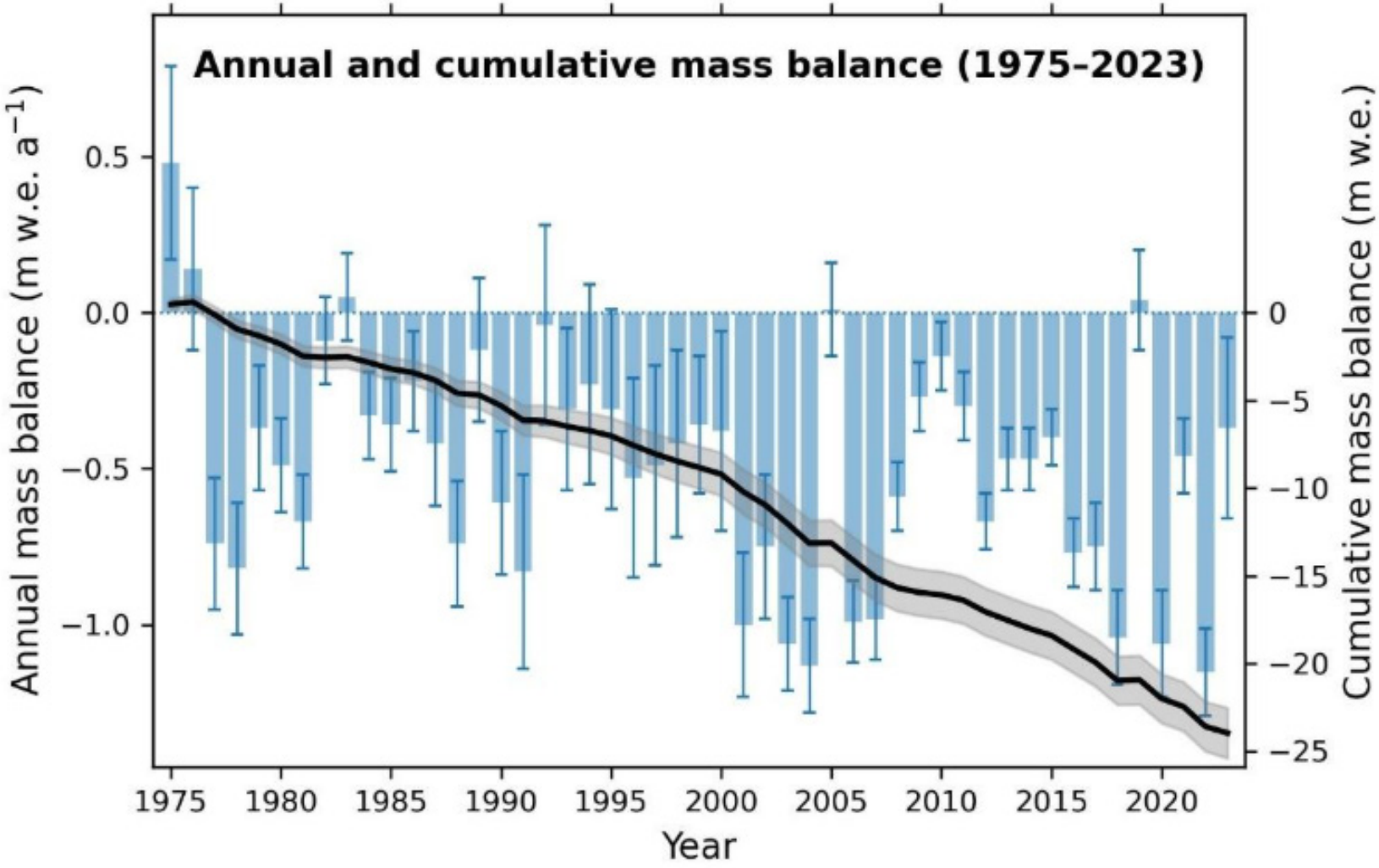


Chhota Shigri Glacier (western Himalaya, India), representing the longest mass balance series in the Himalaya, showed the maximum wastage of –1.71 ± 0.24 meters of water equivalent per year (m w.e. a^{-1}) between 2002 and 2021/22. Most glacier monitoring programs were discontinued after 5-10 years of observation, resulting in varying record lengths, uneven spatial distribution, and methodological inconsistencies among glacier-wide mass balance observations (Figure 1). To address this issue and derive a representative Himalaya-wide composite series, a harmonised mathematical framework was developed. All available in-situ glacier-wide mass balance data (38 glaciers; 302 annual observations spanning 1974–2023) were quality-controlled and combined using an area and duration-weighted approach to minimise bias arising from short records and the overrepresentation of smaller glaciers.

Figure 2 shows the estimated mean annual glacier-wide mass balance and cumulative mass balance series since 1974. This series indicates a persistently negative regional mass balance over the past five decades, with a long-term estimated mean of −0.62 ± 0.33 m w.e. a^{-1}. The mean mass wastage nearly doubled from −0.31 ± 0.34 m w.e. a^{-1} pre-2000 (1974–1999) to −0.66 ± 0.33 m w.e. a^{-1} post-2000 (2000–2023). The most recent decade exhibits enhanced interannual variability and increasingly frequent extreme melt years, culminating in exceptional losses during 2021/22 (−1.15 ± 0.14 m w.e. a^{-1}). Cumulative mass loss since 1974 reflects a substantial reduction in glacier storage across the Himalaya, amounting to –23.95 ± 1.44 meters of water equivalent (m w.e) over 1974–2023.

Trend analysis shows a statistically significant acceleration in glacier mass loss since 1974, with a Sen's slope of −0.0093 m w.e. a^{-1}, indicating that annual mass loss has intensified by about 9 cm water equivalent per decade.

FIGURE 2: **LIGHT BLUE HISTOGRAMS SHOW THE MEAN ANNUAL GLACIER-WIDE MASS BALANCE SERIES SINCE 1974, ALONG WITH ANNUAL UNCERTAINTIES, WHILE THE BLACK CURVE SHOWS THE CUMULATIVE MASS WASTAGE SINCE 1974. THE SHADED ENVELOPE REPRESENTS THE ACCUMULATED UNCERTAINTY OF THE CUMULATIVE MASS-WASTAGE CURVE.**



Benchmark and representative glaciers in the Himalaya

None of the currently available mass-balance series in the Himalaya qualifies as a *'reference glacier'*, which requires a minimum of 30 years of continuous measurements according to the guidelines of the World Glacier Monitoring Service (WGMS). To address this limitation, WGMS introduced the term *'benchmark glacier'* for glaciological mass-balance programs that have not yet reached the 30-year threshold but are located in regions lacking reference glaciers. A WGMS benchmark glacier must have at least 10 years of ongoing glaciological mass-balance observations.

In the Himalaya, seven glaciers currently qualify as WGMS benchmark glaciers: Mera, Pokalde, Rikha Samba, West Changri Nup, and Yala glaciers in the central Himalaya (Nepal), and Chhota Shigri and Hoksar glaciers in the western Himalaya (India).

To evaluate the representativeness of these seven benchmark glaciers, a detailed assessment was conducted by systematically comparing field-based glaciological measurements with satellite-based geodetic estimates of glacier mass balance. This analysis shows that Mera Glacier in the Khumbu region and Rikha Samba Glacier in Hidden Valley are representative of the central Himalaya, while Chhota Shigri Glacier represents the western Himalaya. These findings highlight the importance of sustained long-term monitoring of these key glaciers.

Photo: Jitendra Raj Bhacharya/ICIMOD

Photo: Jitendra Raj Bhacharya/ICIMOD

Way Forward

Strengthening glacier monitoring across the Hindu Kush Himalaya (HKH) requires coordinated regional action focused on expanding observation networks into underrepresented regions, such as the Karakoram, Sikkim, Zanskar, and the Bhutanese Himalaya. At the same time, it is essential to sustain long-term monitoring of benchmark and representative glaciers and to standardise monitoring methodologies to improve the comparability of datasets across the region. It is also recommended to share the mass balance data with WGMS to increase the representation of Himalayan glaciers' climate change response at global scale.

The International Year of Glaciers' Preservation (IYGP 2025) and the Decade of Action for Cryosphere Science (2025–2034) provide an important strategic framework for mobilising investments, enhancing collaboration among member countries, and strengthening the scientific foundation required for reliable hydrological forecasting, hazard assessment, and climate-resilient planning.

For a detailed version of this document, please refer to Azam MF (2026) 50 years of Himalayan glacier mass balance monitoring: recommendations in honour of IYGP 2025, *Journal of Glaciology*.

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International Centre for Integrated Mountain Development

GPO Box 3226, Kathmandu, Nepal

T +977 1 5275222 | E info@icimod.org | www.icimod.org