ICIMOD

From Recognition to Action: Advancing the Mountain Agenda within the UNFCCC

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Director General
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Why mountains matter globally

Mountains cover roughly 24% to 27% of the Earth's land surface

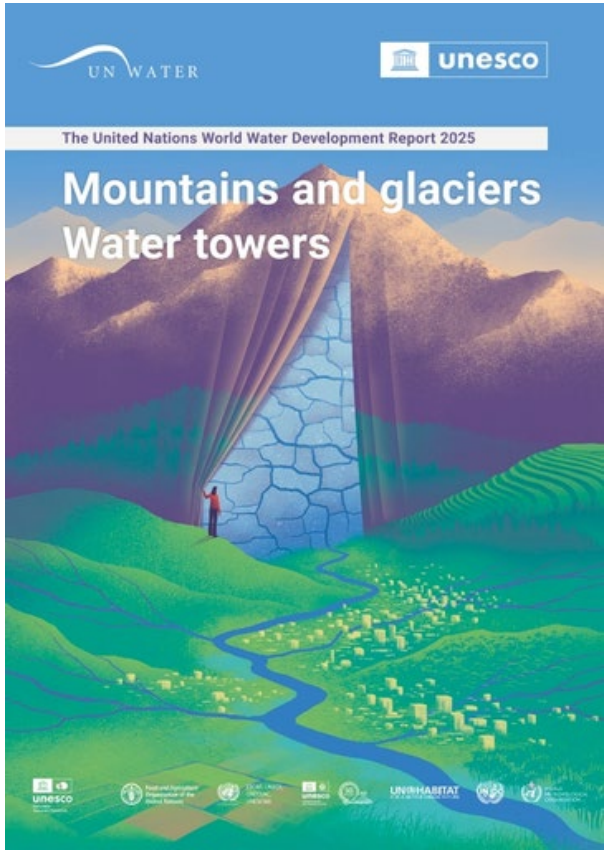
critical for climate resilience, water security, biodiversity, disaster risk reduction, and sustainable development.

Climate hot spots, warming faster than many regions- serving as early warning systems and barometers of global climate action.

Mountain systems provide 55–60% of global freshwater flows, supporting over 2 billion people.

Climate impacts in mountains are a global challenge, not just a mountain issue.

Without stronger integration of mountain risks into NDCs, NAPs, and climate finance, achieving the Paris Agreement goals will be difficult.



UNESCO, 2025 World Water Development Report

The science demands urgent action

Mountains are warming at rates significantly above the global average — the IPCC identifies mountain and polar regions as among the most rapidly changing systems on Earth (IPCC AR6).

2023 recorded the largest glacier mass loss in five decades of continuous observation (UNESCO / WMO, International Year of Glaciers' Preservation, 2025).

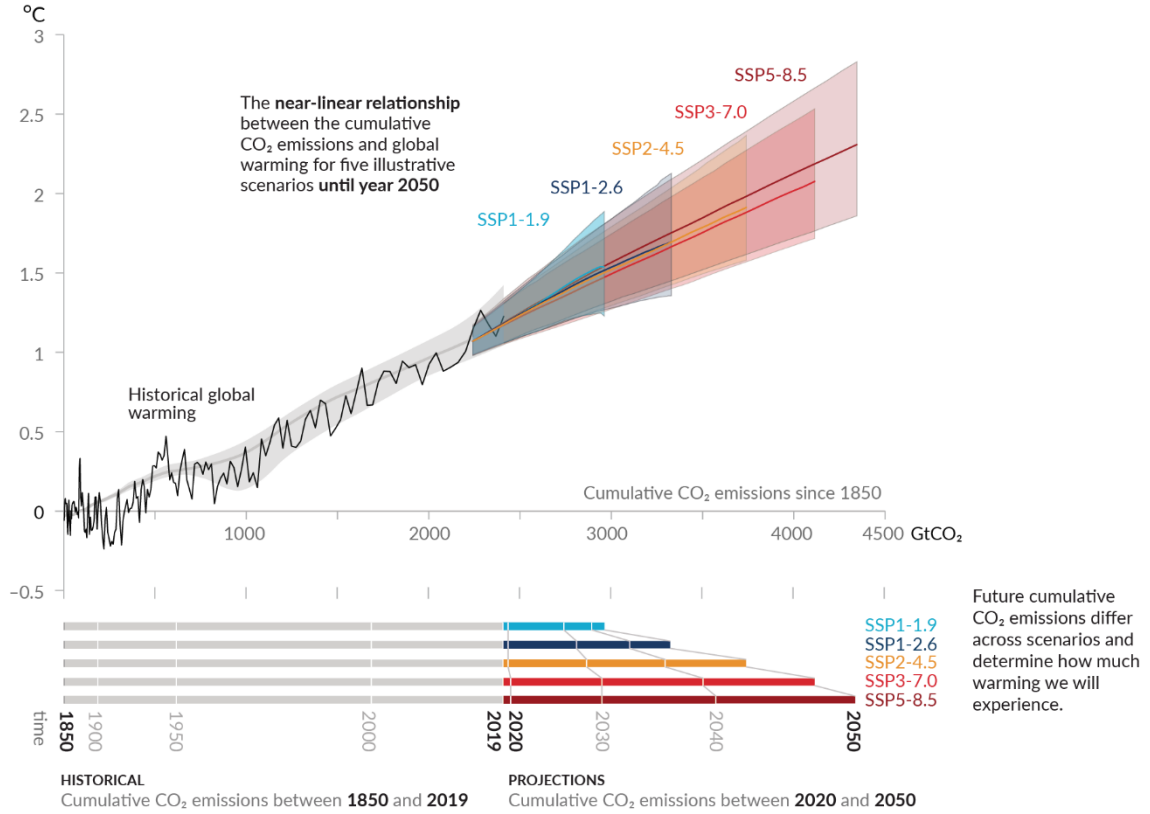
Between 1975 and the end of 2025, Earth's glaciers lost roughly 9,600 gigatons of equivalent to the size of Germany, 25 meters thick, and directly contributes to global sea-level rise while posing critical water-security threats to billions of people (WMO)

Permafrost degradation is destabilizing slopes, infrastructure, and carbon stores in mountain regions, adding systemic risk beyond water and ice (IPCC, UNEP).

The window for meaningful climate action that preserves mountain systems is narrowing — the science demands that the UNFCCC act now, not later.

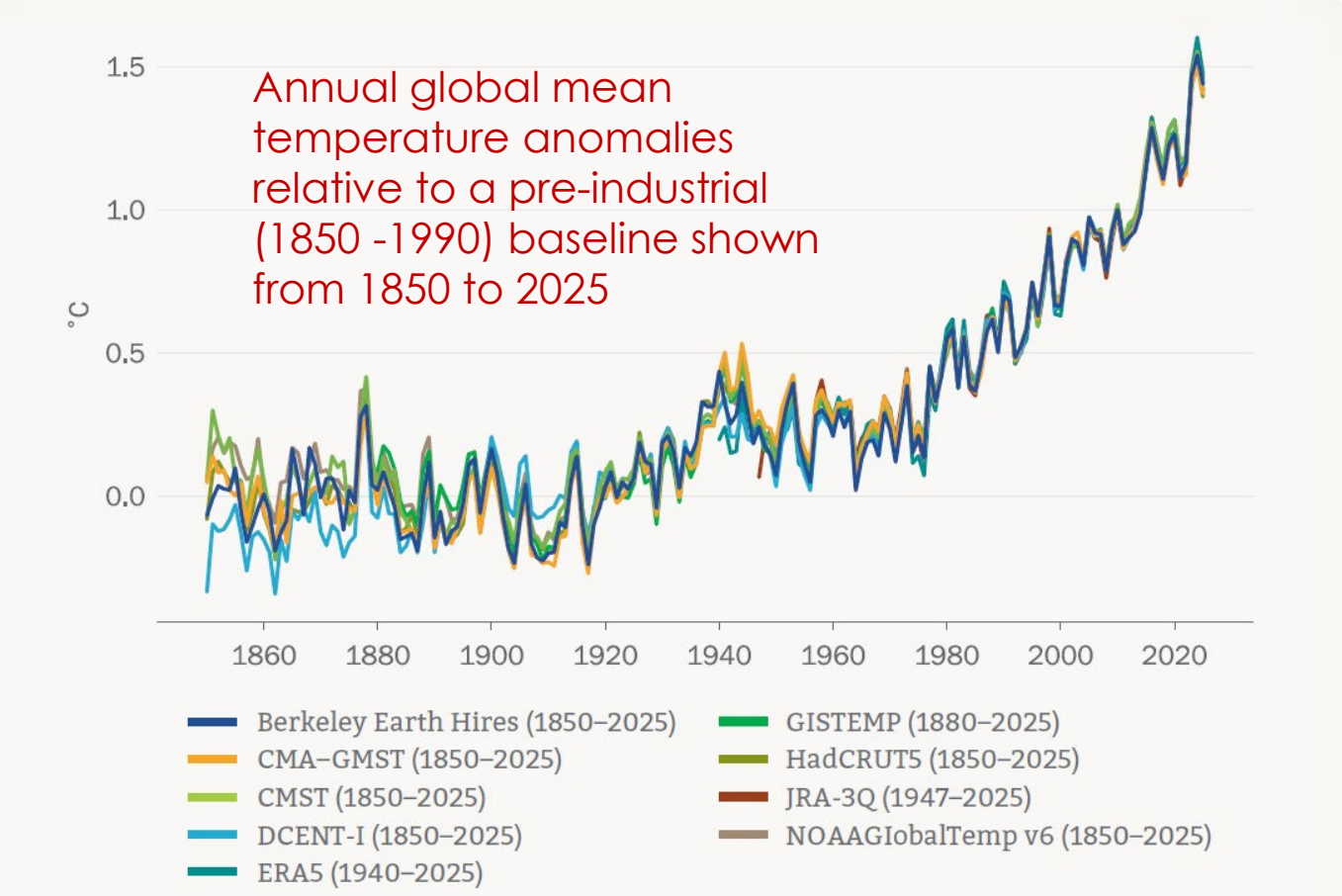
Every tonne of CO_2 emissions adds to global warming

Global surface temperature increase since 1850–1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)



Source: IPCCAR6

Alarming global warming



World Meteorological Organization. (2026). *State of the global climate 2025*. https://doi.org/10.59327/WMO/SJCRI/SOC/1

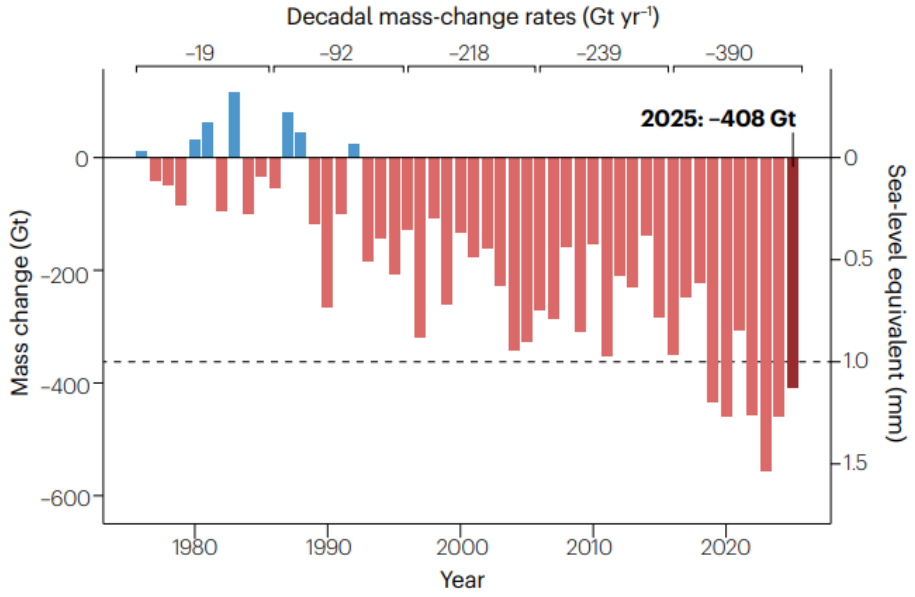
The warmest year was 2024 with anomaly of **1.55°C ± 0.13°C.**

The past eleven years (2015 – 2025) were the **warmest years on record and past three years are the three warmest in all datasets.**

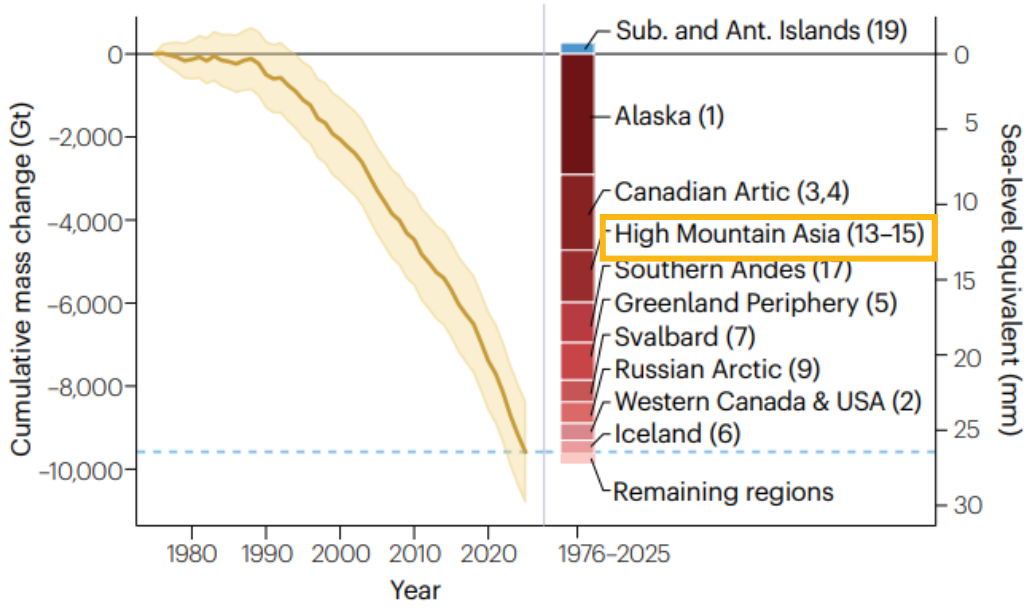
A single year above 1.5°C in 2024 doesn't mean the 1.5°C limit has been exceeded.

Global Glacier Changes

The WGMS Network 2026: Global glacier mass change in 2025



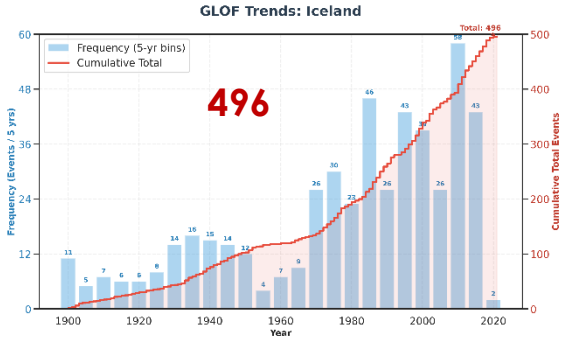
2025 was the sixth-highest glacier mass-loss year globally in the past 50 years, with a total loss of 408 ± 132 Gt.

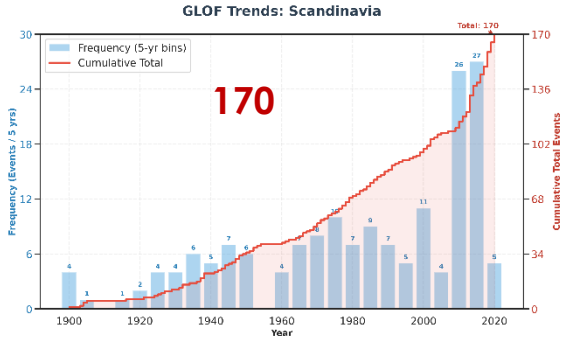


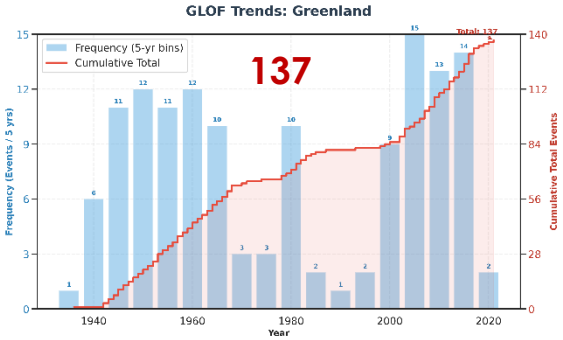
HMA ranked **third globally in cumulative glacier mass-loss** contribution during 1976–2025.

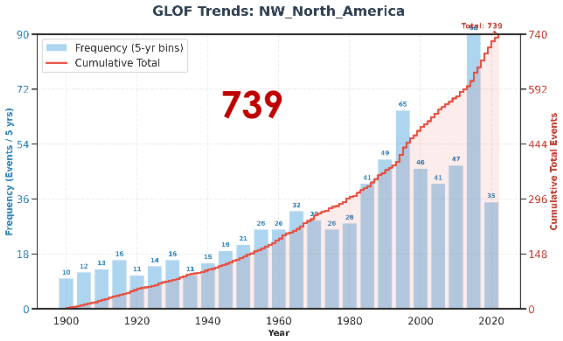
In 2025, **HMA was the largest regional contributor, losing 88 ± 32 Gt** of glacier mass.

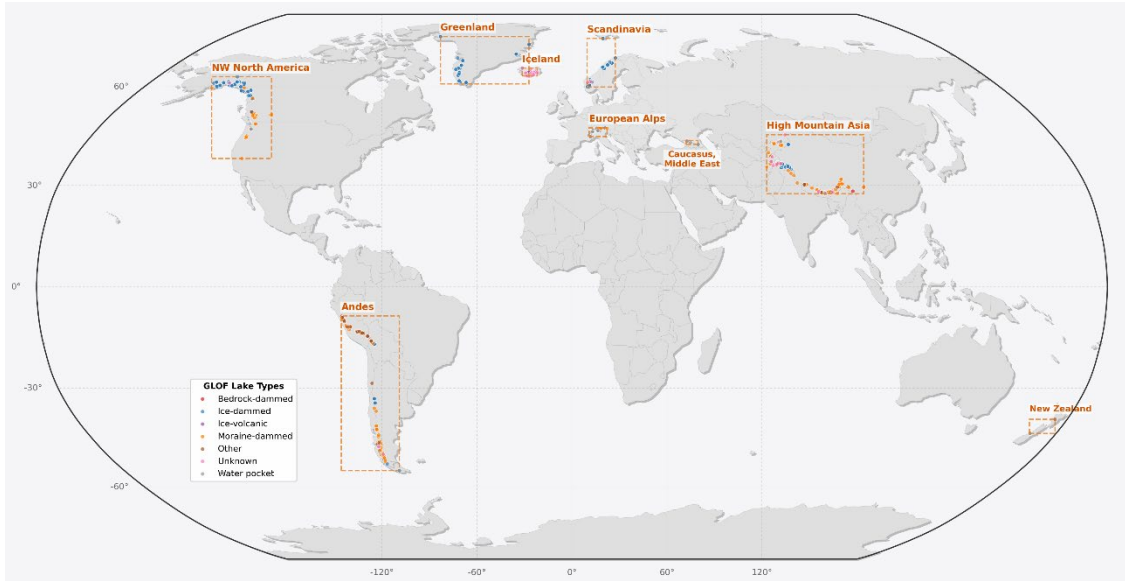
Global GLOF Events (1900 to 2022)

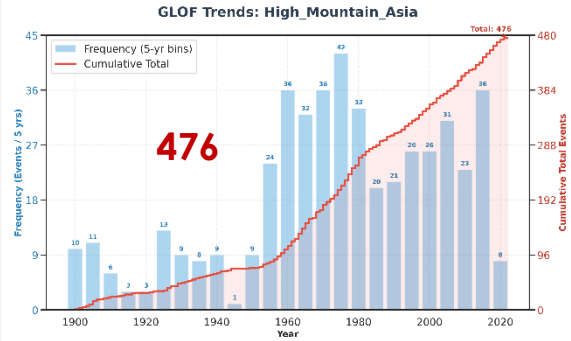


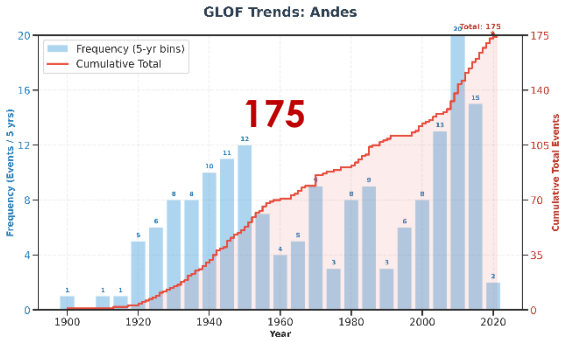


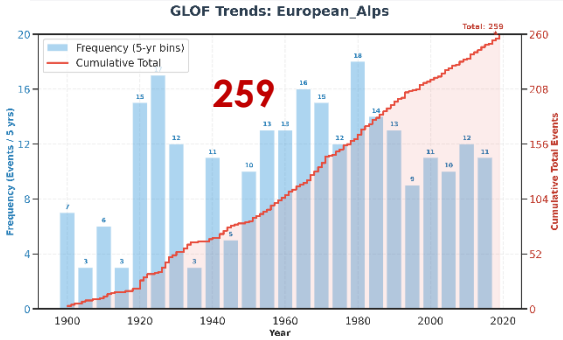


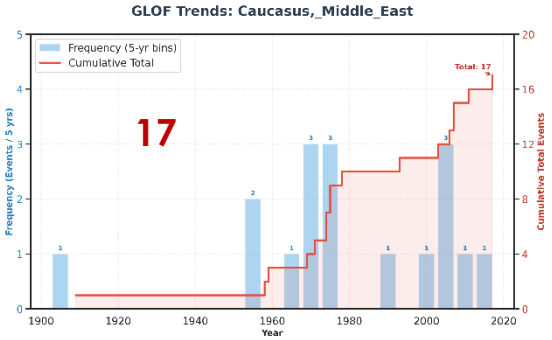


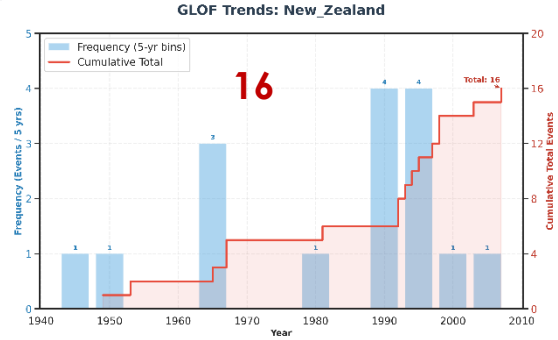






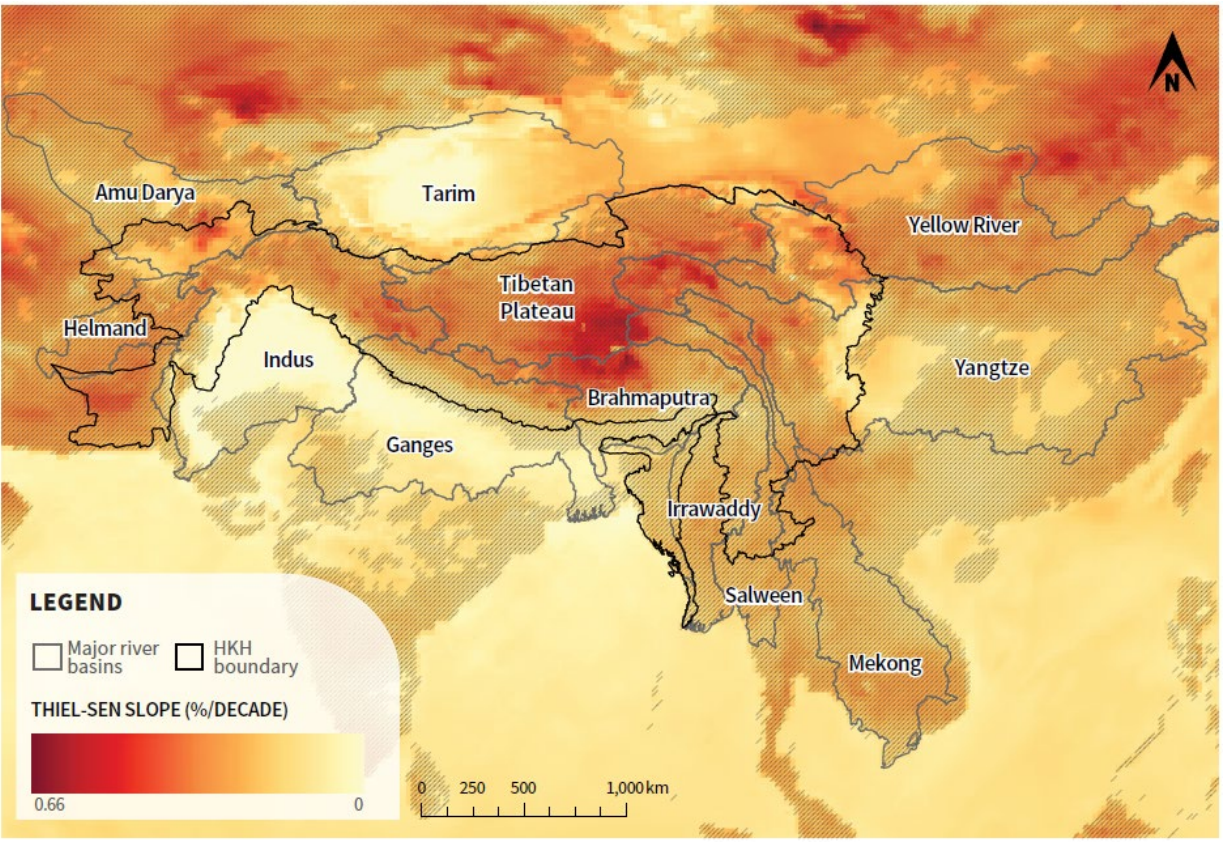






Source: Lützow, N., Veh, G., and Korup, O., (2023), A global database of historic glacier lake outburst floods, *Earth System Science Data*

Climate change in the HKH

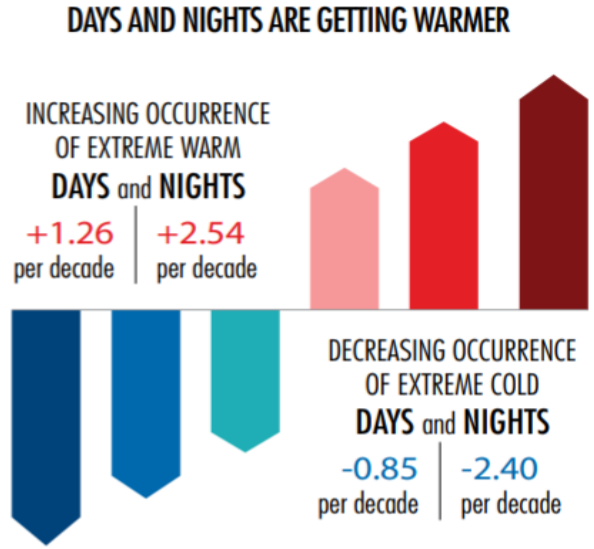


Average annual mean temperature trend in HKH (1951 – 2020)

Mean temperature (1951 -2020) trend varies from +0.15°C/decade to +0.34°C/decade in all basins

Tibetan Plateau and eastern basins (Brahmaputra, Mekong, Yangtse basins) shows higher trend up to +0.66°C per decade.

EDW: areas of higher elevation (>4000 masl) showing warming trend (+0.34°C per decade).

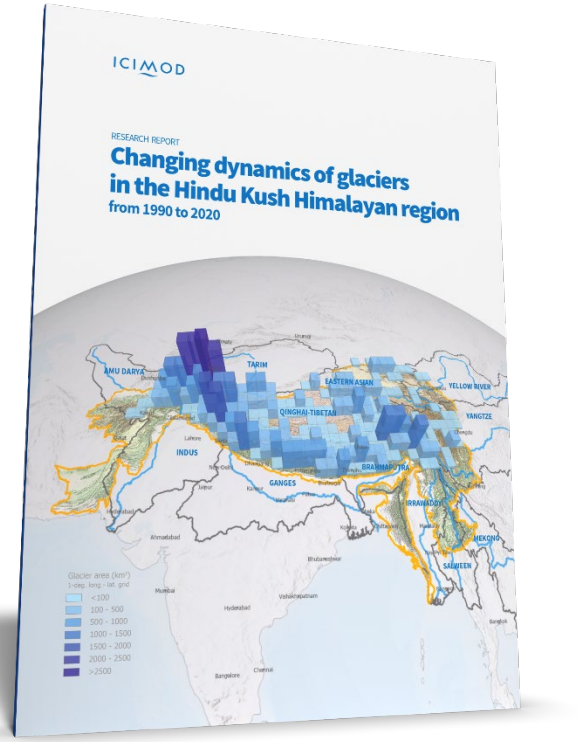


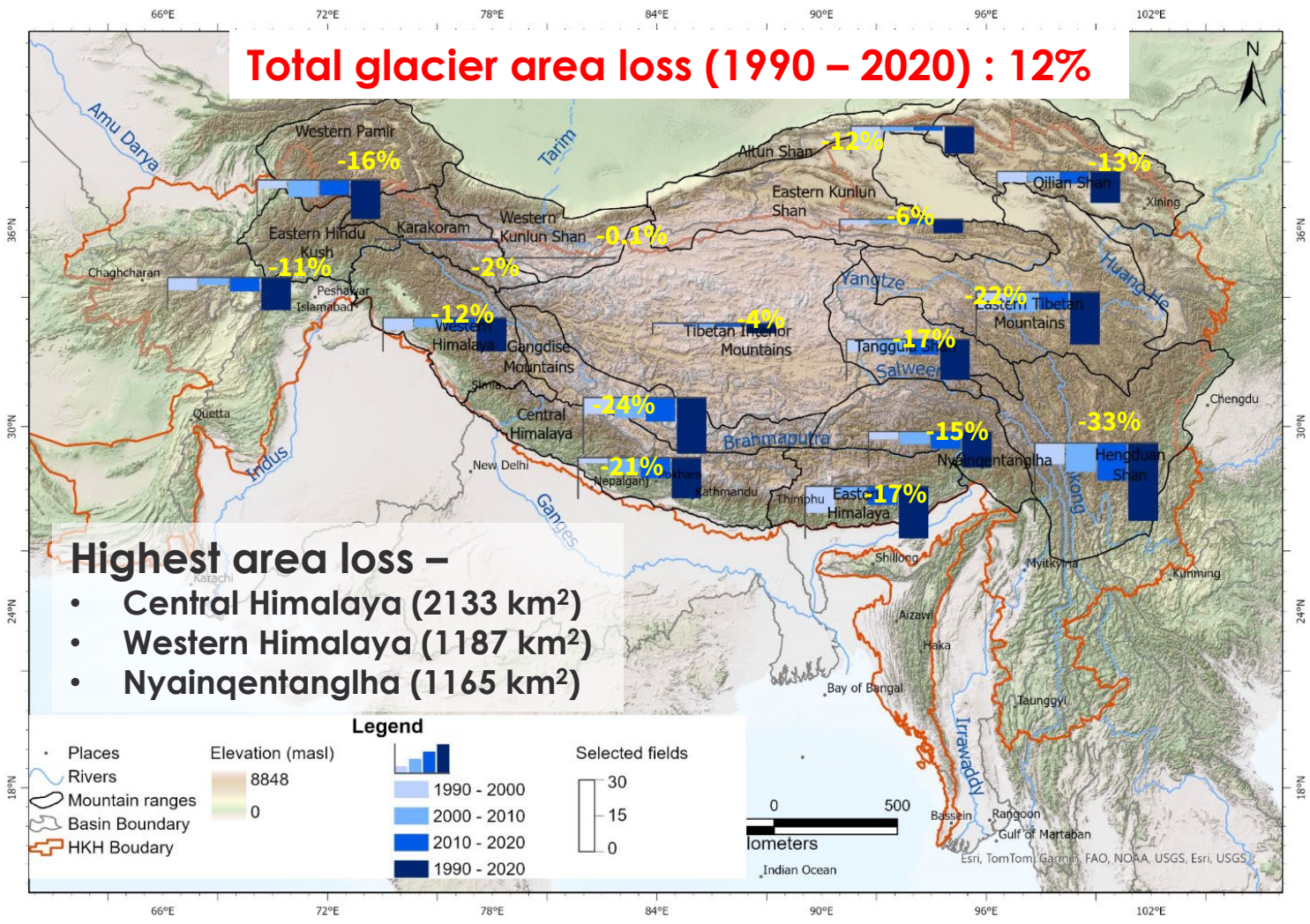
PRECIPITATION TREND

Increasing extreme precipitation

Increasing annual intensity and frequency of intense precipitation

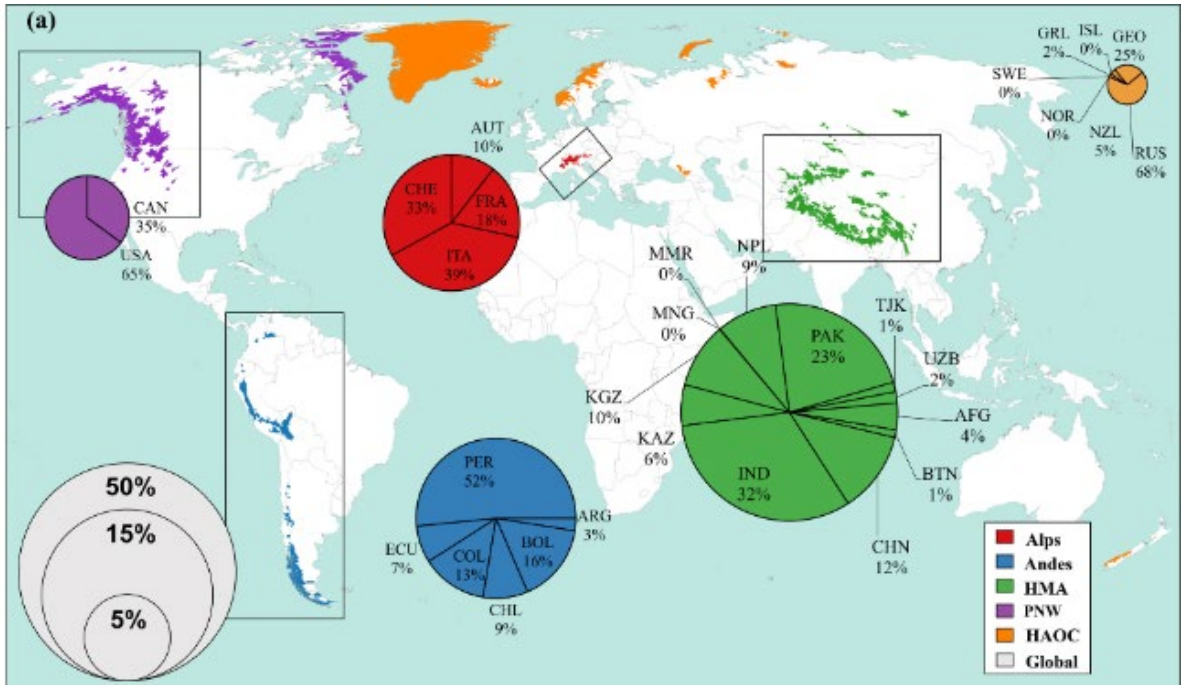
Decadal Changes of Glaciers in the HKH Region (1990 – 2020)

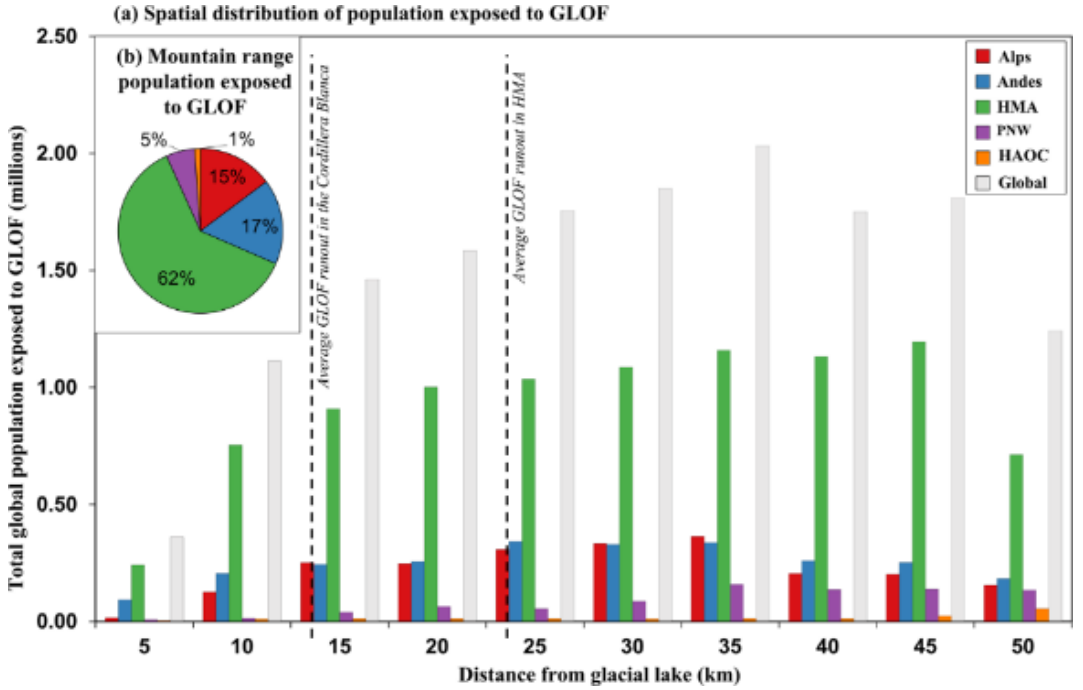




1990	2000	2010	2020
63,121.52 km²	61,099.24 km²	58,676.32 km²	55,782.04 km²

Populations exposed to GLOFs



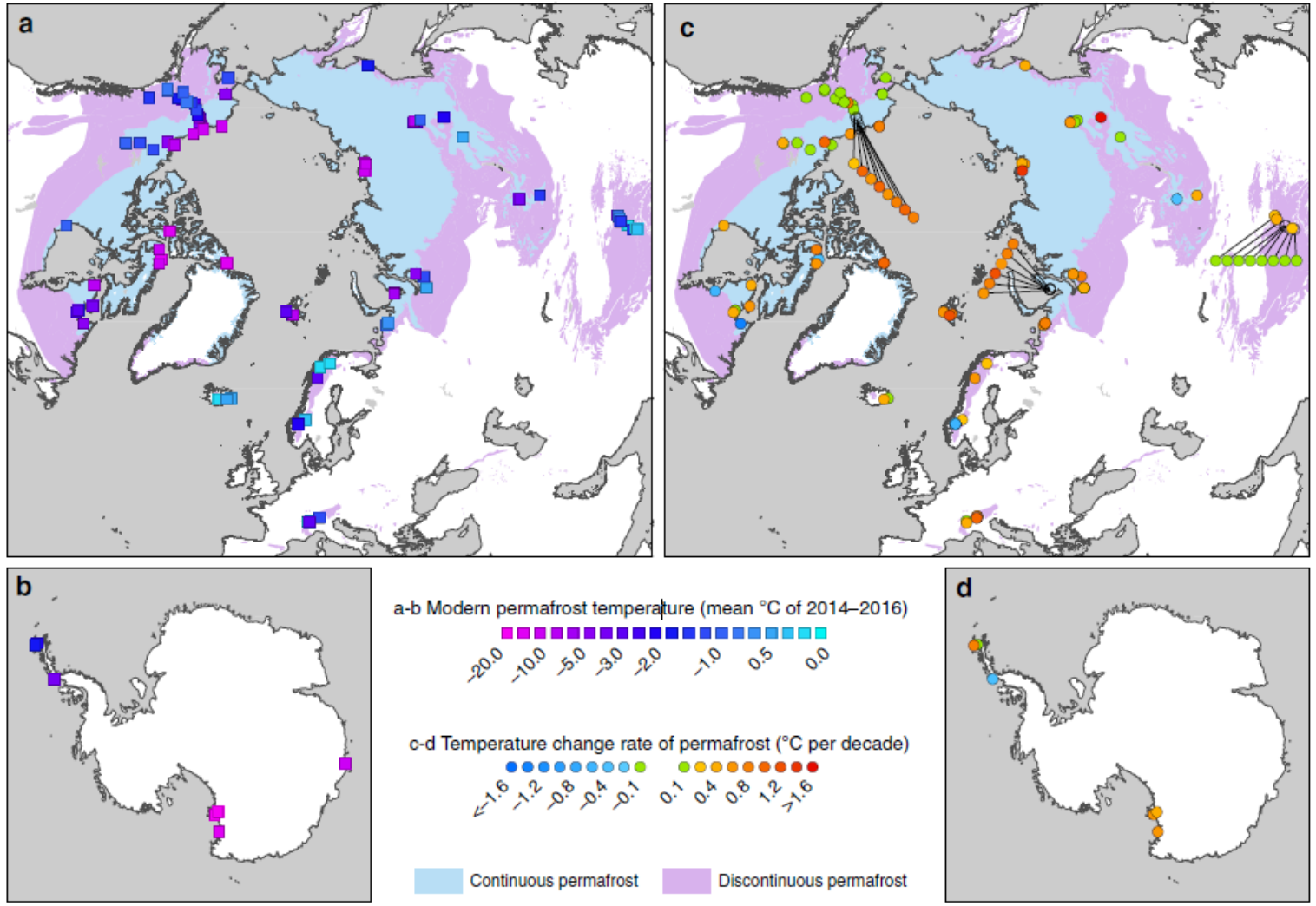


Populations in High Mountains Asia (HMA) are the most exposed and on average live closest to glacial lakes with ~1 million people living within 10 km of a glacial lake.

Source: Taylor et al., 2023 (Nature communications)

PERMAFROST IN A WARMING CRYOSPHERE

Observed borehole evidence shows
permafrost warming across polar and mountain regions.



HISTORICAL ESTIMATED GLOBAL PERMAFROST AREA in 1981–2010

14.1 ± 4.5 million km²

MULTIPLE METHODS INDICATE MAJOR UNCERTAINTY IN GLOBAL AREA ESTIMATES

UNDER SSP5-8.5: PROJECTED GLOBAL PERMAFROST AREA IN 2070–2099

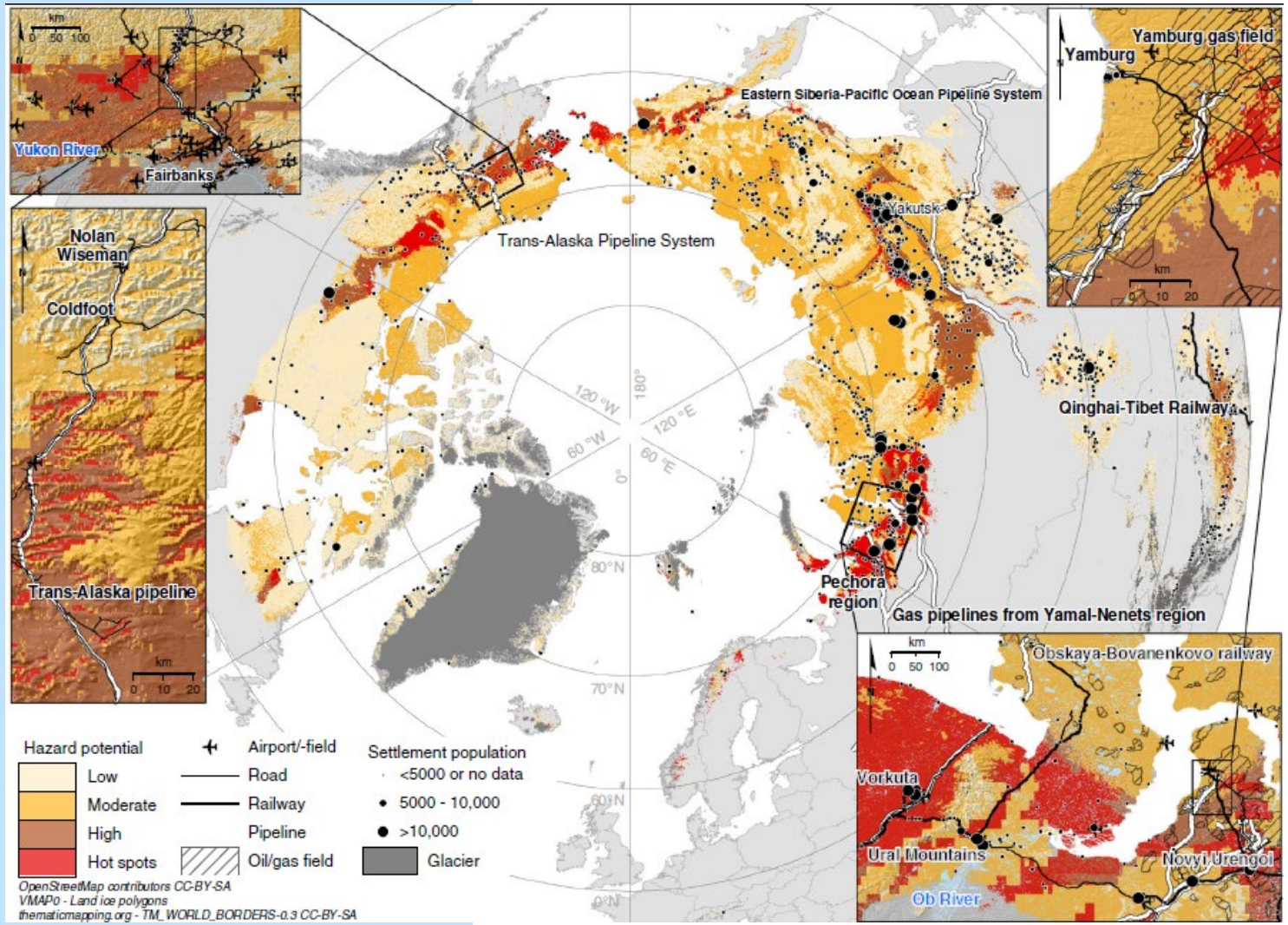
1.3 – 8.2 million km²

51.2%–86.9%

DECREASE IN PERMAFROST AREA

Lower-latitude permafrost margins are especially vulnerable under high-emissions scenarios.

Global consequences of permafrost degradation on carbon and infrastructure



Possible additional warming by 2100 from Permafrost Carbon Feedback

INCREASE BY

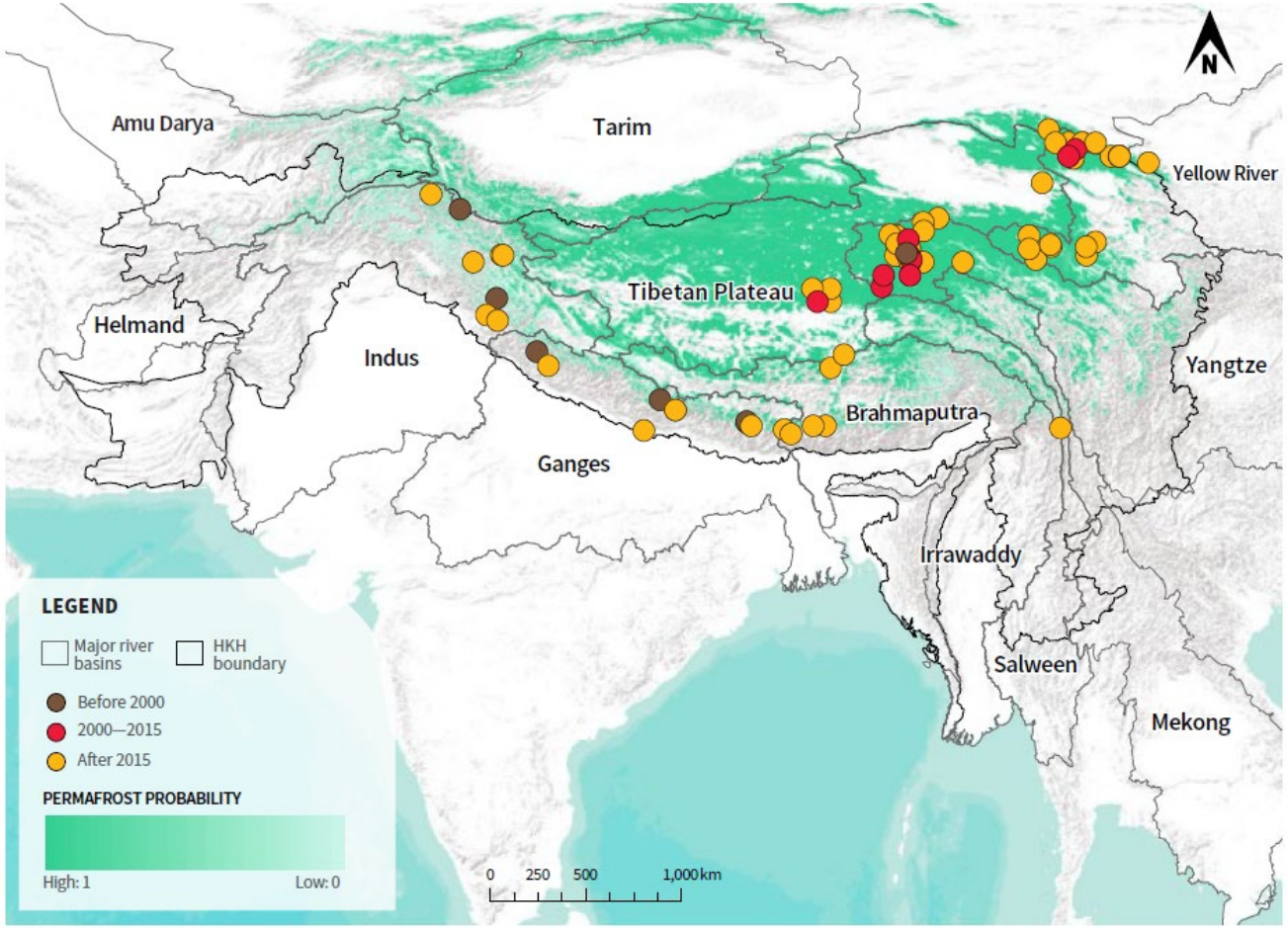
0.13 – 0.27 °C

70%

OF CURRENT INFRASTRUCTURE IN THE NORTHERN HEMISPHERE'S PERMAFROST ZONES ARE UNDER POTENTIAL THREAT DUE TO PERMAFROST DEGRADATION BY 2050

Infrastructure-related costs could rise up to tens of billions of USD.

Permafrost in the Hindu Kush Himalaya



HKH outlook: thaw and knowledge gaps

TIBETAN PLATEAU	2/3rd	of permafrost projected to be degraded by 2071-2099 under high emissions
WESTERN HIMALAYA	8,340 km²	loss in permafrost area between 2002-2004 and 2018-2020
UTTARAKHAND HIMALAYA	965 km²	loss in permafrost area between 1970-2000 and 2001-2017

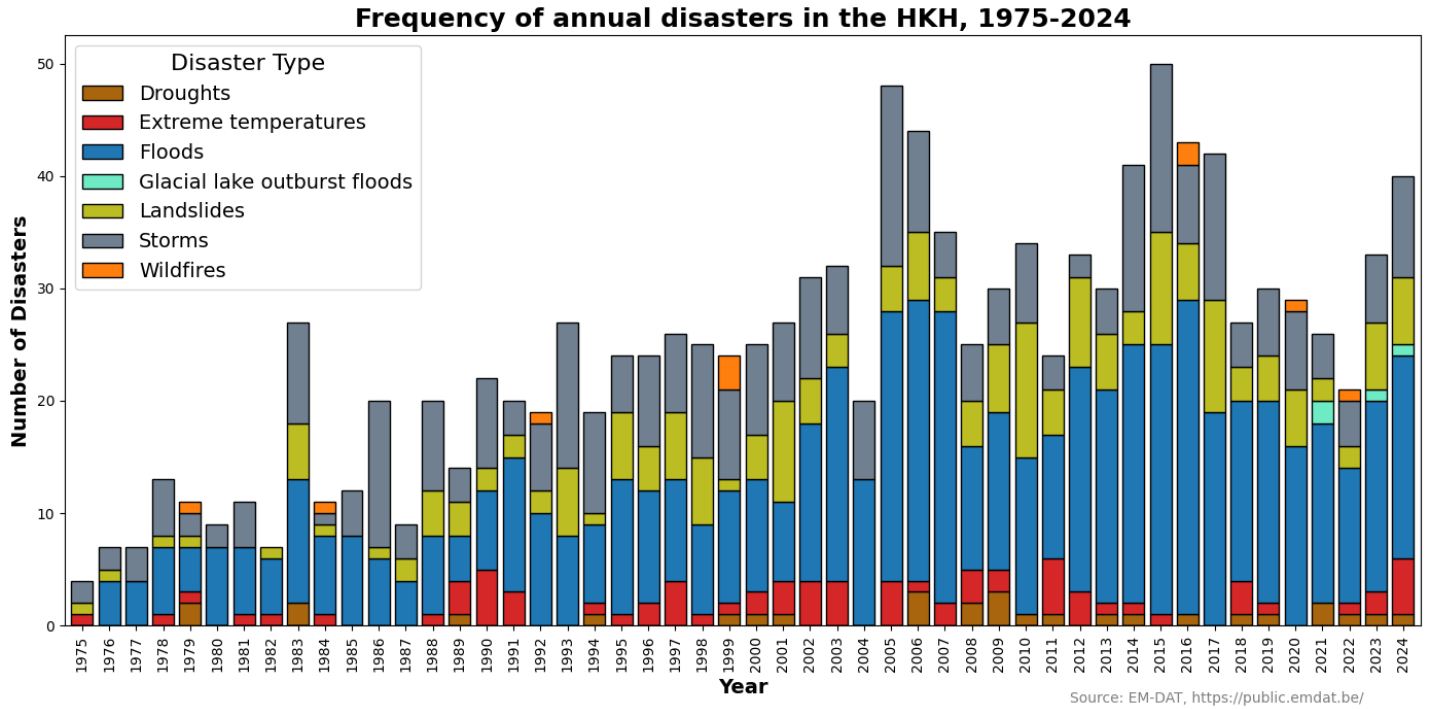
Projected permafrost extent reductions are rare and mostly Tibetan Plateau-focused, but available studies suggest about 40% loss after mid-century and 40%-80% loss by end-century; active-layer thickness is projected to increase.

Disaster event across the HKH region

The number of disasters has been increasing across the HKH region.

However, the proportion of people affected has not increased significantly.

This suggests better climate services and preparedness in the region.



	Event	Death	Injured	Affected	Damage
1975-1999	483	245259	0.88 M	1.41 B	B$ 212.35
2000-2024	975	260387	1.22 M	1.58 B	B$ 539.14

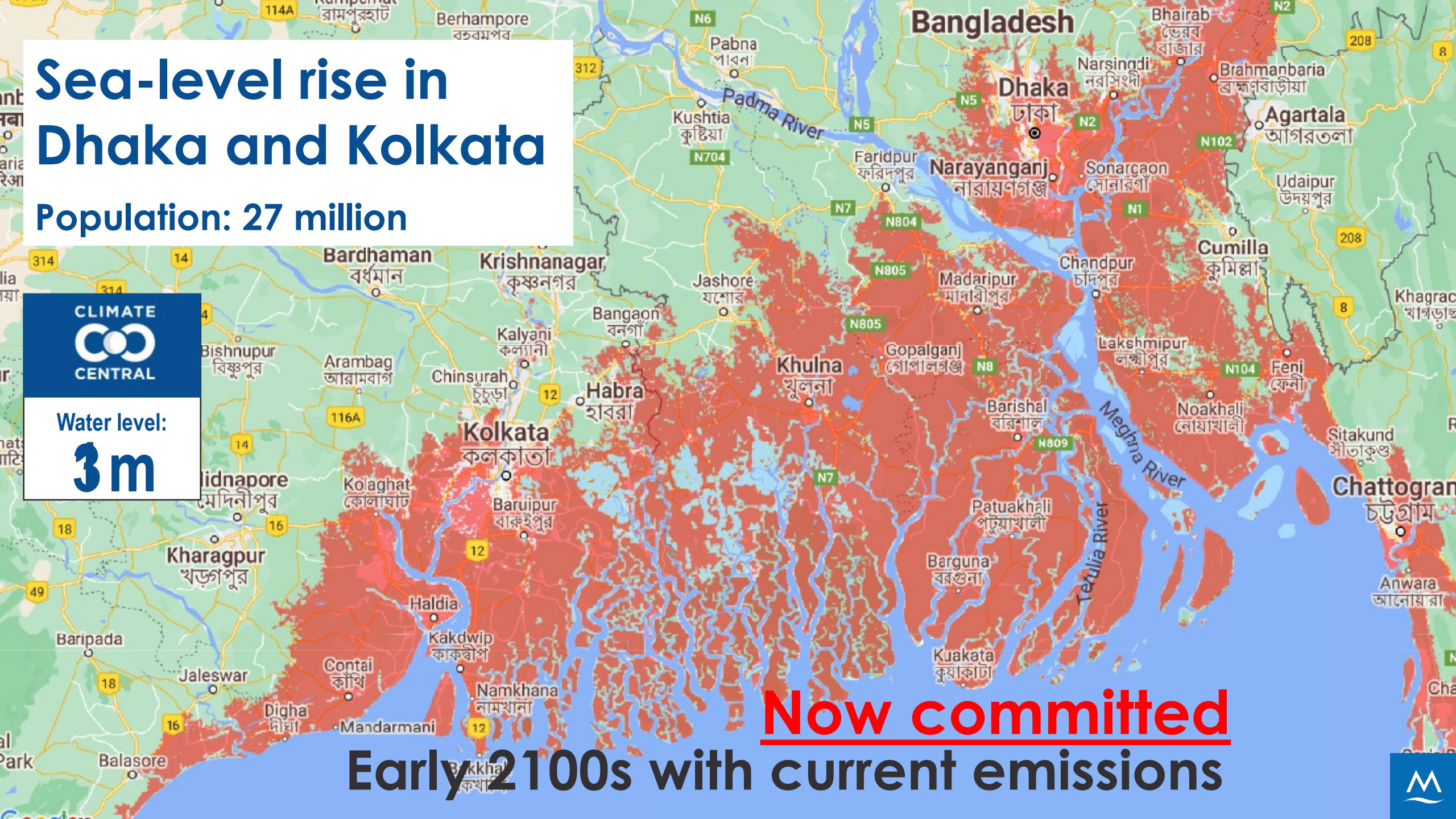
Sea-level rise in Dhaka and Kolkata

Population: 27 million

CLIMATE CENTRAL

Water level:

3 m



Now committed

Early 2100s with current emissions

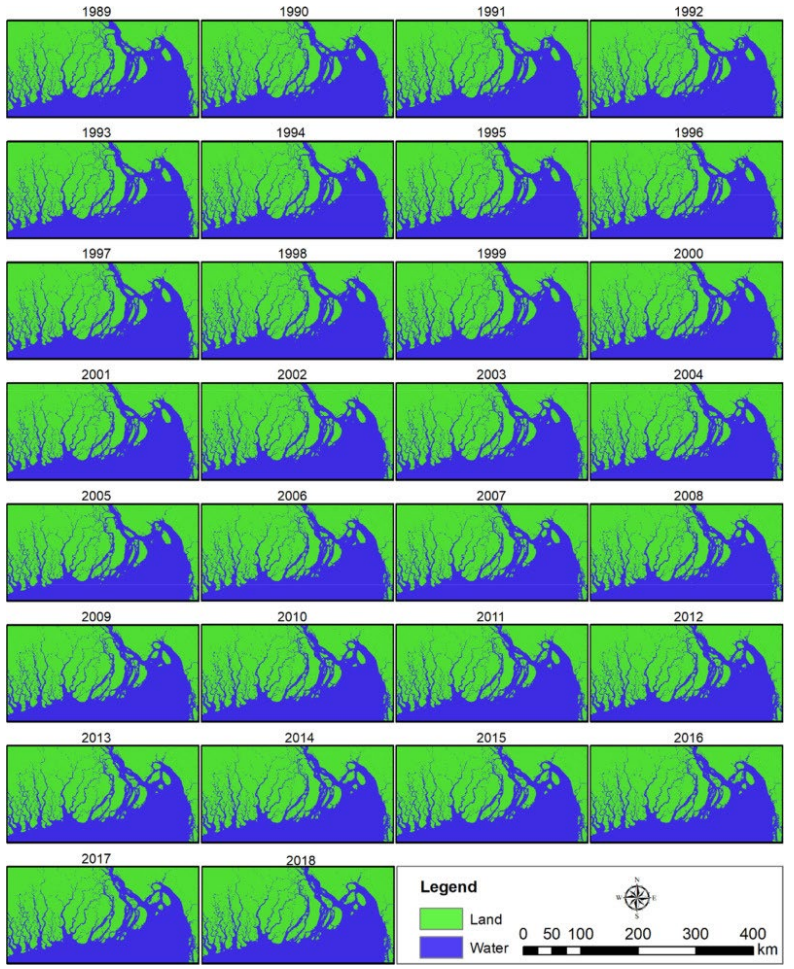
Coastal Ecosystem & Northern Bay of Bengal

Sediment Input: Ganges–Brahmaputra 316 – 721 million tons per year

Impacts:

- ❑ Submergence of 'productive land' threatens national food security and livelihood
- ❑ **Sea-level rise & erosion threaten delta stability**

Source: Rahman et al. 2018; Yu et al. 2010 & Uddin, K., Khanal, N., Chaudhary, S., Maharjan, S., & Thapa, R. B. (2020



Annual land and waterbodies map between 1989 and 2018, used to determine erosion and acceleration of the coastal region, derived from cloud-free Landsat imagery.

Image: Uddin et al., 2020)

Key impacts of mountain disasters in the Andes

GLOFS, ICE/ROCK AVALANCHES

PEOPLE AND HEALTH

Deaths, evacuations and trauma; warning lead times can be minutes to hours.

Peru Apr 2025: rockfall → GLOF → Huaraz

~30 families displaced

INAIGEM 2024:

4,889 homes modelled at risk in Huayhuash alone

WATER, FOOD & ECOSYSTEMS

Deaths, evacuations and trauma; warning lead times can be minutes to hours.

Peru Apr 2025: rockfall → GLOF → Huaraz

~30 families displaced

INAIGEM 2024:

8,466 glacial lakes nationwide;

528 at overflow risk;

58 'very high'

INFRASTRUCTURE & ECONOMY

Homes, roads, bridges, hydropower and tourism assets exposed downstream.

Peru Apr 2025: rockfall → GLOF → Huaraz

144 bridges destroyed

INAIGEM 2024:

350M potential losses modelled (Huayhuash scenario)

Sources: INAIGEM 2023-24 (PE) · IDEAM 2023-24 (CO) · DGA 2022-25 (CL) · IANIGLA (AR) · WMO LAC 2024-25 · IAM/CONDESAN 2023 · AFP/France24 (Ecuador 2024)

Key impacts of mountain disasters in the Andes

FLOODS, FLASH FLOODS, AND LANDSLIDES

PEOPLE AND HEALTH

Fatalities, injuries, isolation of highland communities and settlements.

Peru Mar 2023

71 deaths, 517,000 affected; 1,030 districts in state of emergency

Colombia

33 killed Risaralda 2022; 37 killed El Carmen 2024 (Andean highway)

Piura 2023

Maternal mortality ↑: dengue linked to 20% of maternal deaths

WATER, FOOD & ECOSYSTEMS

Crop and livestock losses; contaminated drinking water and damaged irrigation.

Peru 2023 – flood landslide

85,000 households lost crops

Andean valley

River sedimentation disrupts water intakes and aquifers

IAM/CONDESAN

More intense rainfall events increasing erosion and mass movements

INFRASTRUCTURE & ECONOMY

Road closures, bridge failures, schools/clinics damaged; trade corridors disrupted.

Peru 2023

54,000 homes damaged, 144 bridges destroyed

Columbia

88% of natural disasters are hydrometeorological; landslides rank 2nd cause of disaster deaths

Sources: INAIGEM 2023-24 (PE) · IDEAM 2023-24 (CO) · DGA 2022-25 (CL) · IANIGLA (AR) · WMO LAC 2024-25 · IAM/CONDESAN 2023 · AFP/France24 (Ecuador 2024)

Key impacts of mountain disasters in the Andes

DROUGHT, HEAT & GLACIER RETREAT

PEOPLE AND HEALTH

Water rationing, heat stress, health risks and migration pressure.

Quito 2024

38 days no rain; water + electricity rationing; 20/24 provinces on red alert

Bogotá 2024

8M people on water rotation; reservoir fell to 16% capacity

IDEAM

Colombia may lose all glaciers by end of century; forced community migration

WATER, FOOD & ECOSYSTEMS

Pasture loss; camelids, potatoes and quinoa affected; dry-season flows decline.

Andean

1.3M people in severe drought conditions (WFP 2023); Andean highlands most exposed

DGA (Chile)

Andes glaciers losing capacity to buffer megadroughts by 2100

Peru -56%, Bolivia -43% glacier mass → decrease Amazon flow up to 20%

IDEAM 2024

Colombia lost 6.8% glacier area in 2 yrs; El Niño 22% worse than 2015-16

INFRASTRUCTURE & ECONOMY

Irrigation, urban supply, energy generation and basin allocation conflicts.

Ecuador 2024

73.6% of energy from hydro → halted by drought; US$12M lost/hr of blackout

DGA (Chile)

26,180 glaciers = ~80% of Andean total; all 25 monitored show retreat

IANIGLA (AR)

Andes Desérticos glacier surface -17% in last decade; Mendoza/Cuyo water at risk

WMO 2025

90M people depend on Andean glacier meltwater

Sources: INAIGEM 2023-24 (PE) · IDEAM 2023-24 (CO) · DGA 2022-25 (CL) · IANIGLA (AR) · WMO LAC 2024-25 · IAM/CONDESAN 2023 · AFP/France24 (Ecuador 2024)

Áncash, Peru

169 glacial lakes at risk of outburst

26 classified as very high risk

More than 27,000 people directly exposed to potential flooding from Lake Palcacocha

Huaraz (~120,000 inhabitants) is one of the world's largest cities exposed to glacial lake hazards.

Casca (Peru, 2025)

A mountain disaster linked to glacierized catchments triggered floods and debris flows that caused fatalities, damaged water infrastructure, disrupted livelihoods and affected downstream communities in Huaraz.

Mountain communities on the frontline

Mountain communities contribute little to global emissions **yet face some of the most severe climate impacts**.

Adaptation challenges include difficult terrain, high infrastructure costs, limited-service access, data/monitoring gaps, and constrained institutional capacities.

Adaptation in mountains is often more expensive and technically demanding than in lowland areas.

Despite these constraints, **mountain communities demonstrate remarkable innovation** through ecosystem-based adaptation, traditional knowledge systems, community-based monitoring, and integrated watershed management.

Reducing impact and risk

The impact of climate change and extreme events will become more frequent in the future – potentially affecting new locations and areas in future - leading to more severe and frequent disasters.

Reducing Emission of Green House Gas.

Promoting Environment Friendly Systems

Reducing Black Carbon (Soot) Pollution

Strengthen Climate Policies

Enhancing Monitoring Systems and Risk Assessments

Proper Land Use, Infrastructure, and Development Planning and Implementation

Adopting a Glaciers to Oceans Approach

Strengthen Regional and Global Collaboration and Coordination

Raise Public and Community Awareness and Preparedness

Digital tools for early insights & awareness

Integrated Digital Solutions for Flood Management and Landslide Hazard Awareness

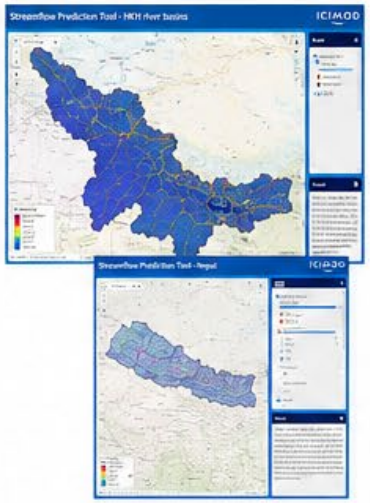
FLOOD MANAGEMENT SERVICES

1 HIWAT

- Weather forecast – 2 days
- Rainfall, temp, lighting etc.
- 12 ensemble
- Prakop Alert-Mobile app

Rainfall Forecast | Temperature | Lightning | Mobile Alert

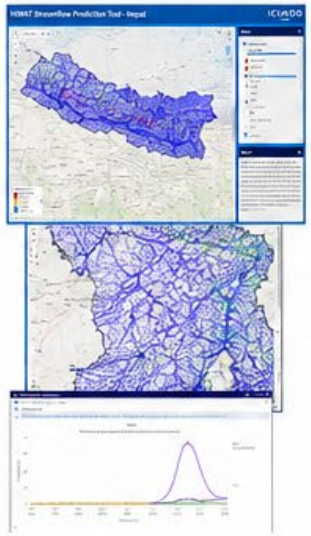
2 Streamflow Prediction Tool



- 10 days lead time
- ECMWF rainfall and runoff
- 52 ensemble

River Basin Flow Forecast | Rainfall & Runoff | 52 Ensemble

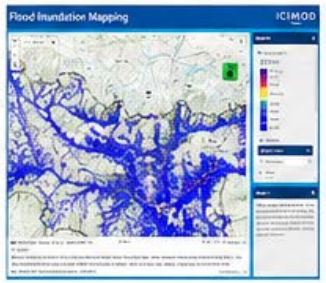
3 Flash Flood Prediction Tool



- 2 days lead time
- HIWAT rainfall
- Localized flood

Rainfall Input | Localized Flood | Flood Hydrograph

4 Flood Inundation Mapping



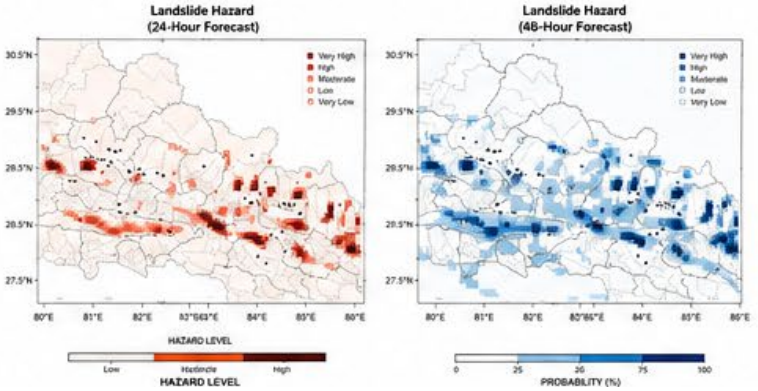
- Flooded and non flooded area
- SAR data- penetrate cloud
- Machine Learning algorithm

Inundation Map | SAR Data | ML Algorithm

DEVELOPING LANDSLIDE FORECASTING TOOL FOR NEPAL

LHASKarnali - Prototype : http://nepal.spatialapps.net/LHASKarnali

- Developing a dynamic event-based landslide forecasting tool for Nepal.
- AI- based model trained using recorded landslide events, satellite derived rainfall data, HiWAT Rainfall forecasts and various static factors.
- Provide forecasts with a lead time of one or two days.



Development of technical guide for glacial retreat

ICIMOD and UNDP are developing a first-of-its-kind technical guide for assessing loss and damage due to glacial retreat in the HKH region and other mountain regions

Primary focus
Hindu Kush Himalaya (HKH), with replicability to other regions

Alignment with WIM
Contributes to Expert Group on Slow Onset Events

KEY CONTRIBUTIONS

01

Addressing Non-Economic Losses

Incorporating losses that are not easily quantified in monetary terms (cultural heritage, ecosystem services)

02

Integrating GESI-Differentiated Risks

Analyze how risks disproportionately affect the different group based on gender, ethnicity, social status and other factors

03

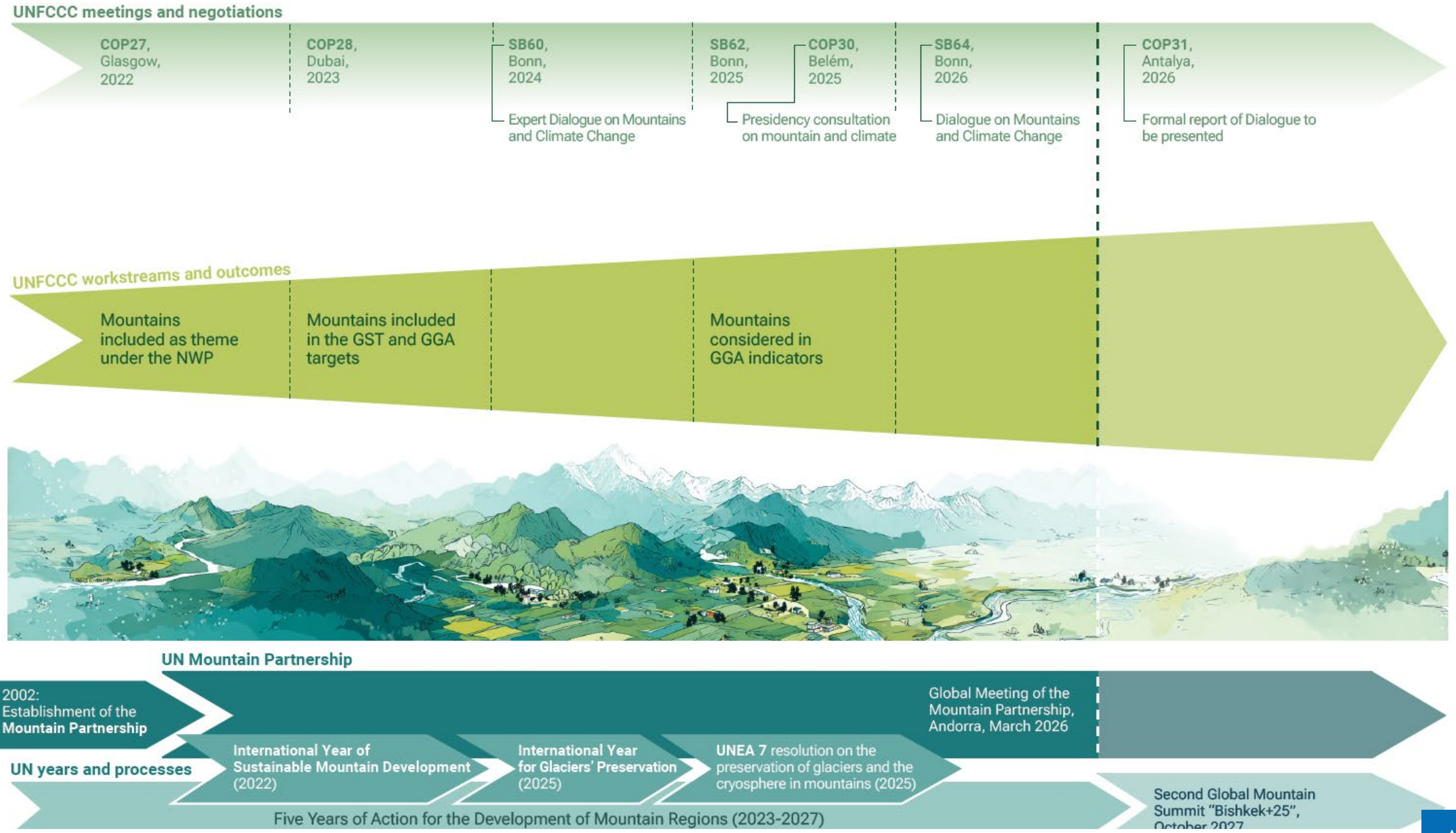
Support Policy

Provide evidence to help policymakers avert, minimize and address Loss and Damage effectively

KEY QUESTION

How do we move from recognition in decisions and dialogues to systematic integration and implementation across UNFCCC processes?

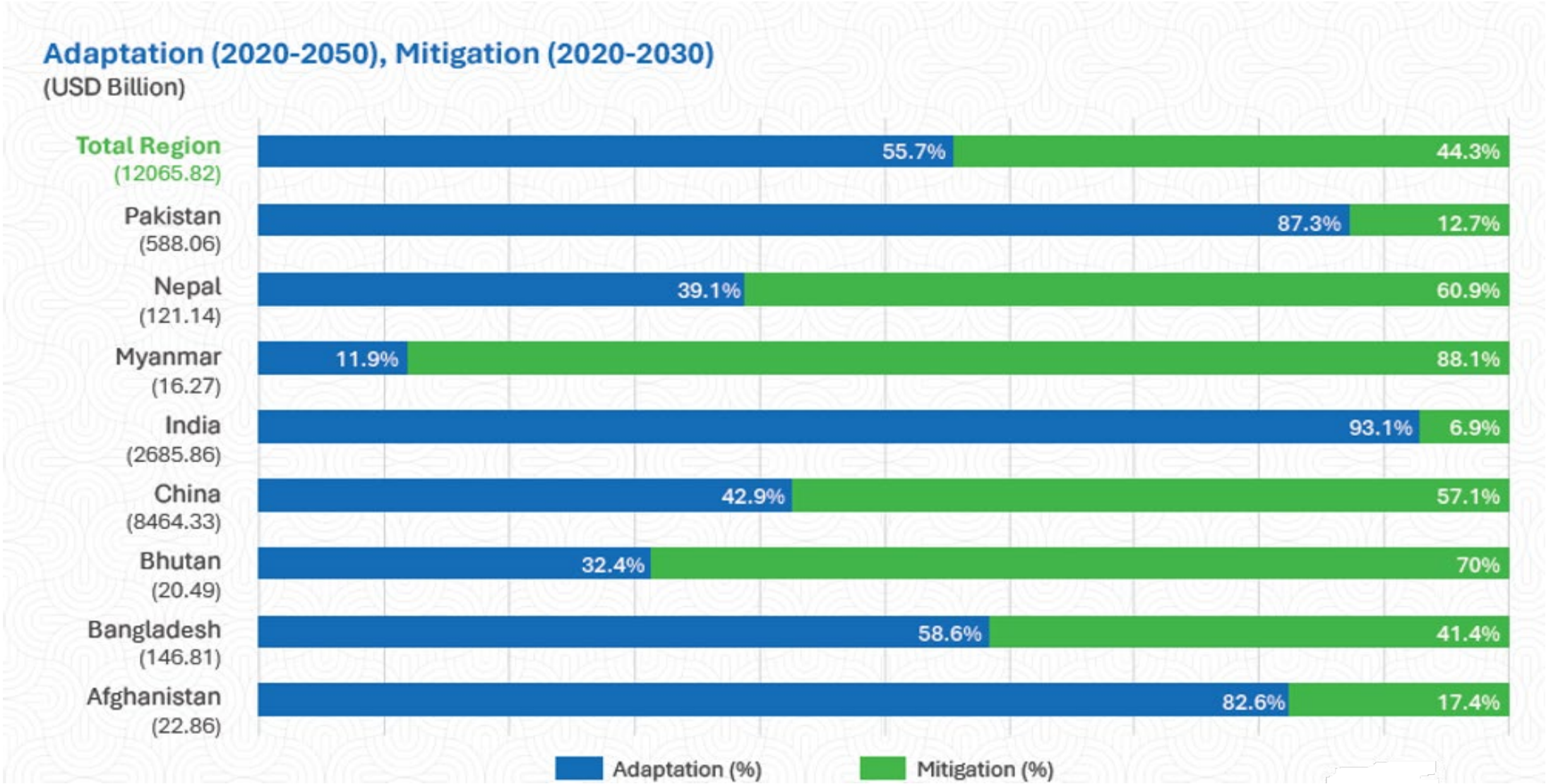
THE JOURNEY SO FAR



Climate Finance Must Reach Mountain Communities

- Mountain regions remain **underfunded** despite being among the most vulnerable and least responsible for emissions.
- Barriers include **high transaction costs, limited project preparation capacity, difficult terrain, data gaps, and small community size**, which constrain access to climate funds.
- **Climate Finance including NCQG and its delivery mechanisms** should explicitly recognize the needs of mountain and cryosphere-dependent countries.
- The **upstream-downstream and transboundary benefits** of mountain investments are often overlooked; eligibility criteria and results frameworks should better capture these benefits.
- The **Fund for Responding to Loss and Damage** should prioritize mountain communities facing irreversible losses, including from GLOFs and displacement.
- **Climate funds** should develop mountain-responsive financing approaches, building on initiatives such as AMAP, HIMAP, SERVIR, and other cryosphere-focused programmes.

Total CF Needs: **USD 12.065 trillion**, Annual **USD 768.68 billion** for HKH Countries



Why Continued Engagement Matters

Growing international momentum — including the International Year of Glaciers' Preservation (2025), the Decade of Action for Cryospheric Sciences, and regional mountain partnerships — demonstrates that mountain issues are attracting increasing global attention.

- Track implementation progress
- Maintain political visibility for mountain and cryosphere issues
- Facilitate exchange of practical experiences from NDCs, NAPs, and BTRs
- Track emerging science and risks; strengthen UNFCCC coordination
- Connect mountain regions: Andes, Alps, Arctic, Caucasus, Central Asia, East Africa, Hindu Kush Himalaya, and others
- Treat mountain regions alongside and not besides other geographical regions

The measure of success should be whether it helps mobilize support, improve implementation, strengthen resilience, and accelerate climate action in mountain regions.

Recognition to Action

- Mountain issues need to be translated into **evidence-based decision-ready language**
- **Connect** mountain issues to the **language of implementation and support**.
- **Shift** in how climate finance defines value
- Mountain investment is often about **public goods**, not just project-level returns
- **Better-designed finance** that understands complexity, supports scale, values prevention, and f**its the geography of mountains**.

Mountains at the Heart of Global Resilience

The science is clear, the risks are growing, and the consequences extend far beyond mountain regions.

The task before us is no longer to demonstrate why mountains matter.

The task now is to ensure that mountain risks, mountain solutions, and mountain communities are systematically reflected across the implementation of the Convention and the Paris Agreement.

This dialogue must help move us from recognition to action.

MOUNTAIN SOLUTIONS PATHWAY

Integrated actions for adaptation, mitigation, resilience and sustainable development delivering benefits for mountains and beyond.

Healthy Mountains
source of life and resilience

Resilient Communities
thriving livelihoods and well-being

Sustainable Future
for mountains and the world

SOLUTIONS PATHWAY

ADAPTATION

Reduce vulnerability and adjust to climate impacts

- Climate-resilient water management
- Ecosystem-based adaptation
- Climate-smart agriculture and livelihoods
- Early warning systems and risk reduction

MITIGATION

Reduce emissions and enhance carbon sinks

- Protect and restore forests and peatlands
- Sustainable land management
- Renewable energy solutions
- Low-emission mountain transport and tourism

RESILIENCE

Strengthen systems and capacity to withstand and recover

- Strengthen institutions and local capacity
- Disaster risk reduction and resilient infrastructure
- Diversified livelihoods and social protection
- Transboundary cooperation on water and ecosystems

SUSTAINABLE DEVELOPMENT CO-BENEFITS

Advance people, planet and prosperity

- Secure water for billions downstream
- Food and energy security
- Biodiversity conservation
- Green jobs and inclusive mountain economies
- Cultural values and Indigenous knowledge

CO-BENEFITS FOR PEOPLE AND PLANET

- Water security for billions downstream
- Healthy ecosystems and biodiversity conservation
- Stronger livelihoods and poverty reduction
- Improved health and well-being
- Climate resilience and reduced loss and damage
- Inclusive green economies and sustainable growth

Healthy mountains. Resilient communities. A sustainable future for all. | Local solutions. Global impact.


Thank You
Let's join hands before its too late!