



Cascading Rock-Ice Avalanche and Hydropower Risk in High Mountain Asia

Findings from the REACH Project

A project supported by a GEO Mountains Small Grant (2024)

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HIGH MOUNTAIN AISA — Changing cryosphere

01

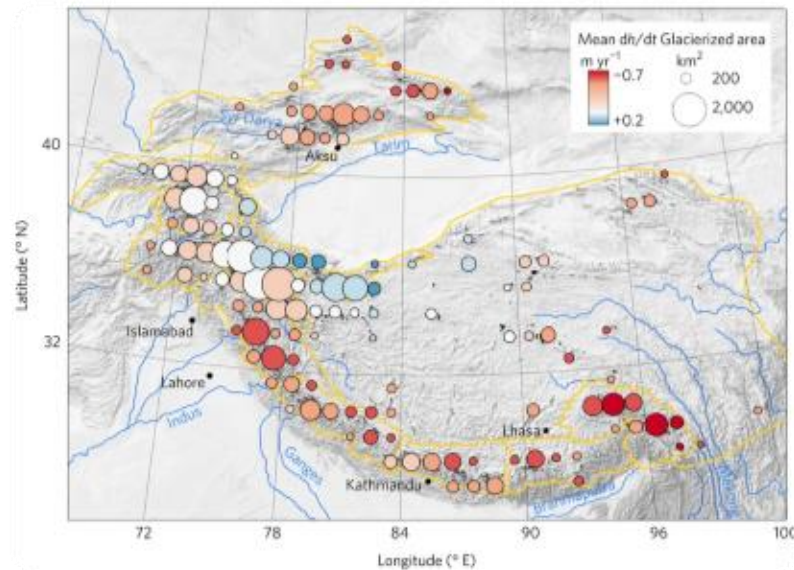
Warmer & Wetter

High Mountain Asia has warmed by ~ 0.3 °C/decade, faster than the global rate of ~ 0.2 °C/decade (IPCC, 2022).

02

Glaciers & Permafrost melting

Glaciers are losing ~ 16 Gt/yr (Brun et al. 2017). Permafrost active layer thickens ~ 2 cm/yr (Wang et al.; Zhao et al., 2020), and snow cover is declining



Why does this matter?

Hydropower potential & development in High Mountain Asia

- Glacier & snowmelt sustain rivers for **2+ billion people**
- Hydropower potential: **>500 GW**
- Energy demand rising due to economic & population growth
- Hundreds of billions of dollars invested in hydropower across High Mountain Asia



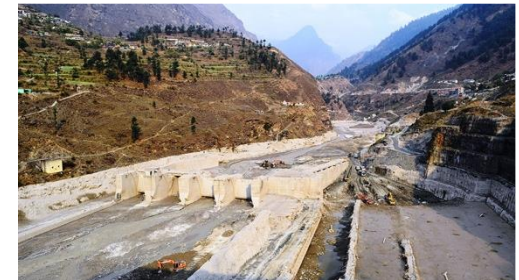
Why does this matter?

Sedongpu, China (2018) 5,758 people affected



Chamoli, India (2021)

Two hydropower projects destroyed,
200+ buried, debris >50
km downstream



ROCK-ICE AVALANCHE HAZARD RISK IS RARELY QUANTIFIED

Core question

Which hydropower stations in HMA are exposed to rock-ice avalanche hazards, and how severe is that exposure?

Four activities

1

Build a regional hydropower installations geodatabase

2

Model RIA hazard and exposure across HMA.

3

Develop an interactive ArcGIS Story Map

4

Deliver a regional workshop (Kathmandu, May 2026)

Team

*Multinational team across Switzerland, China, Nepal, Austria
– with deep regional expertise in HMA.*



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What we built?

Final hydropower dataset:

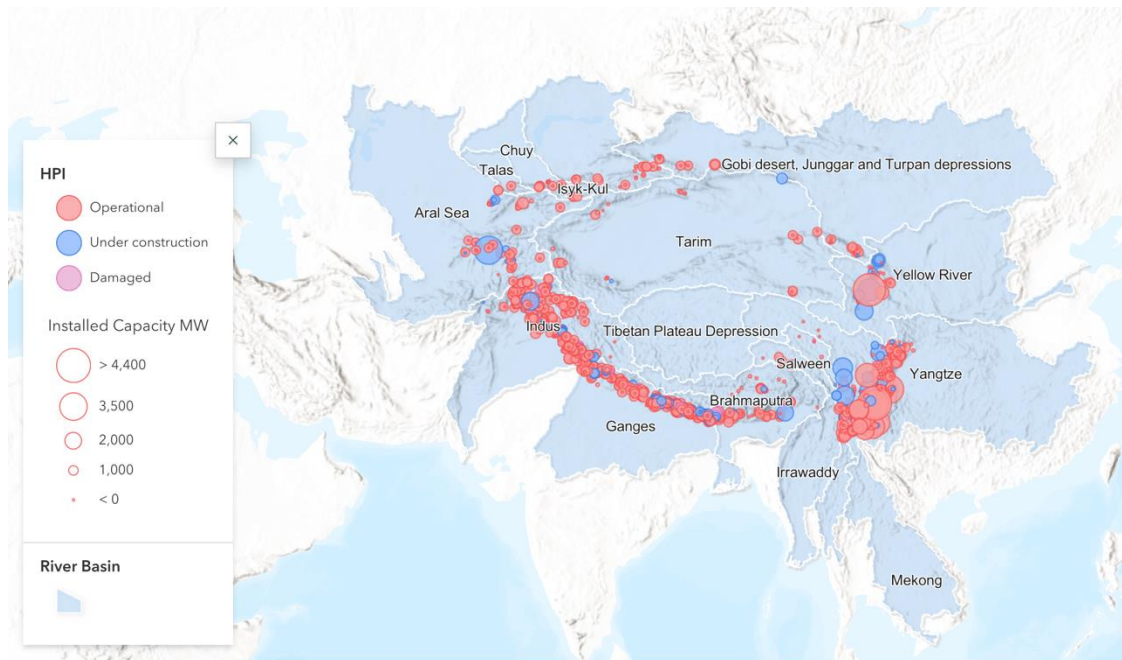
1,118 Hydropower Projects

1,811 Hydropower Installations

1,036 HPIs were newly identified

Hydropower installation database compilation

- Screened 10 global and regional datasets.
- **Manual verification** of >2,800 candidate sites via: **Google Maps**, **search engines**, and **satellite imagery**.
- Verified **small HPIs** using user-submitted photos in Google Map.
- Identified additional HPIs from remote sensing scan.

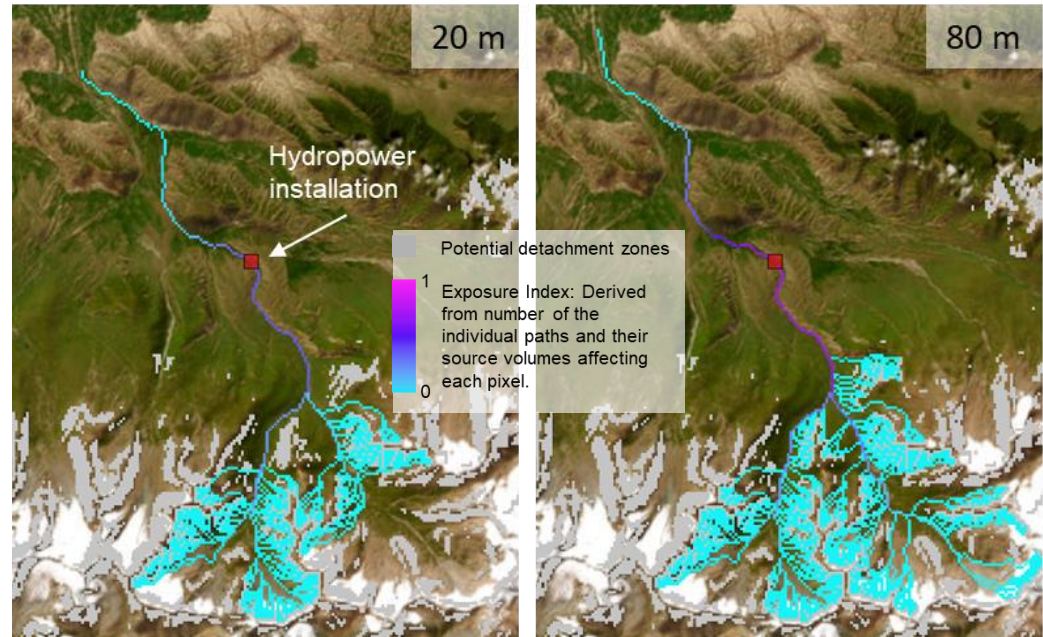


Esri, USGS | Esri, TomTom, Garmin, FAO, NOAA, USGS

What we modelled?

RIA Hazard Modeling

- Flow-path propagation
- Scenarios & Sensitivity Analysis
- Infrastructure Intersection
- Risk Classification
- Spatial aggregation
- Warning time



Key findings

1

50% of hydropower installations in HMA are exposed to RIA hazards

2

9% hydropower installations fall in the highest risk categories

3

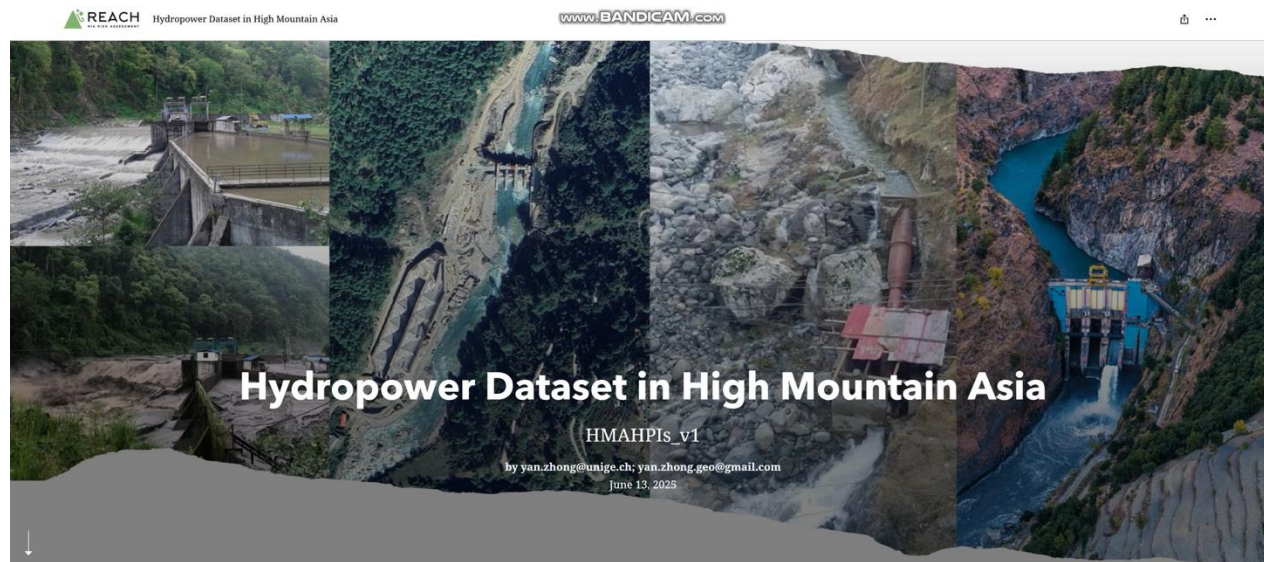
Many high-risk stations are located in catchments with upstream glacial lakes, compounding potential impacts

4

Cascading RIA flow paths intersect with more than 600 glacial lakes before going on to strike HPIs. Only 40% of these lakes had previously been classified as dangerous under conventional GLOF assessments

ArcGIS Story Map

An interactive web-based tool that allows policymakers, development banks, and the public to explore hydropower dataset across HMA



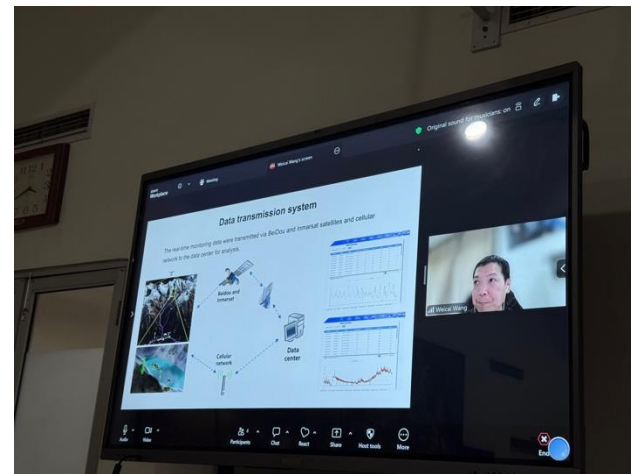
Regional workshop Kathmandu, May 2026

50+ participants (senior scientists, early career researchers, and local students and faculty)

Hybrid format

Outcomes

- Improved understanding of glacial hazard modelling approaches
- Cross-regional exchange between Swiss and HMA institutions
- Strong emphasis on infrastructure exposure, particularly hydropower systems
- Identification of data gaps and needs for integrated multi-hazard frameworks



Next steps

1

Paper acceptance; public release of dataset and Story Map

2

Engage Asian Development Bank to integrate findings into hydropower planning frameworks

3

Integrate REACH dataset into broader regional multi-hazard frameworks

4

Expand cascading hazard modelling in data-scarce environments



Thank you.

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Change Impacts | Natural Hazard Assessmen...



LinkedIn



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