



Monitoring, data & information in mountain environments

James M. Thornton



BOLZANO 2-4 OCTOBER 2023

eurac
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Institute of
Atmospheric Pollution
Research
National Research Council of Italy



GEO Mountains

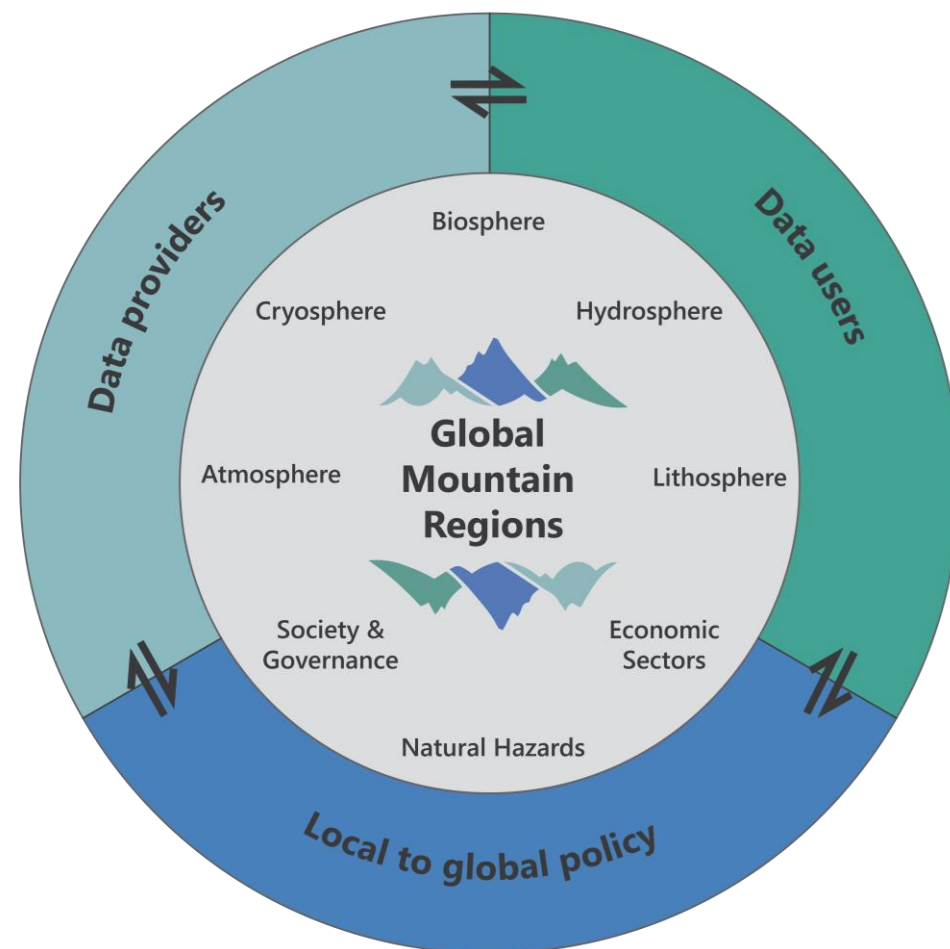


The Global Network for Observations and Information in Mountain Environments

An Initiative of the Group on Earth Observations (GEO) co-led by the Mountain Research Initiative (MRI) & the National Research Council of Italy (CNR)

Objectives:

- To **increase the discoverability, accessibility, and usability** of a wide range of **data and information** pertaining to **mountains globally**
- To **integrate and apply** such data and information for **scientific, policy, and practical impact**
- To **build, connect, coordinate, and share capacity** across a **community** of mountain researchers, practitioners, and policy makers



Adaptation at Altitude



Taking Action in the Mountains

Seeks to increase the resilience and adaptive capacity of mountain communities & ecosystems to climate change



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

<https://adaptationataltitude.org/>

DATA, INFORMATION & MONITORING

We strengthen GEO Mountains, a flagship activity of the Mountain Research Initiative (MRI), under the framework of the intergovernmental Group on Earth Observations (GEO).

MORE >

REGIONAL EXCHANGE & COLLABORATION

We facilitate science-policy dialogues in the Andes, East Africa, Hindu Kush Himalaya, South Caucasus and inter-regional collaboration and sharing of experience.

MORE

KNOWLEDGE & SHARING

We support a community of practice on climate change adaptation in mountains and build a global database of adaptation solutions for mountain regions.

MORE

GLOBAL POLICY MAINSTREAMING

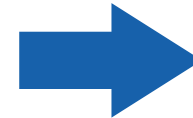
We influence policy processes related to climate change (UNFCCC, Paris Agreement, Global Stocktake), disaster risk reduction (Sendai Framework for DRR), and the Sustainable Development Goals (Agenda 2030).

MORE >

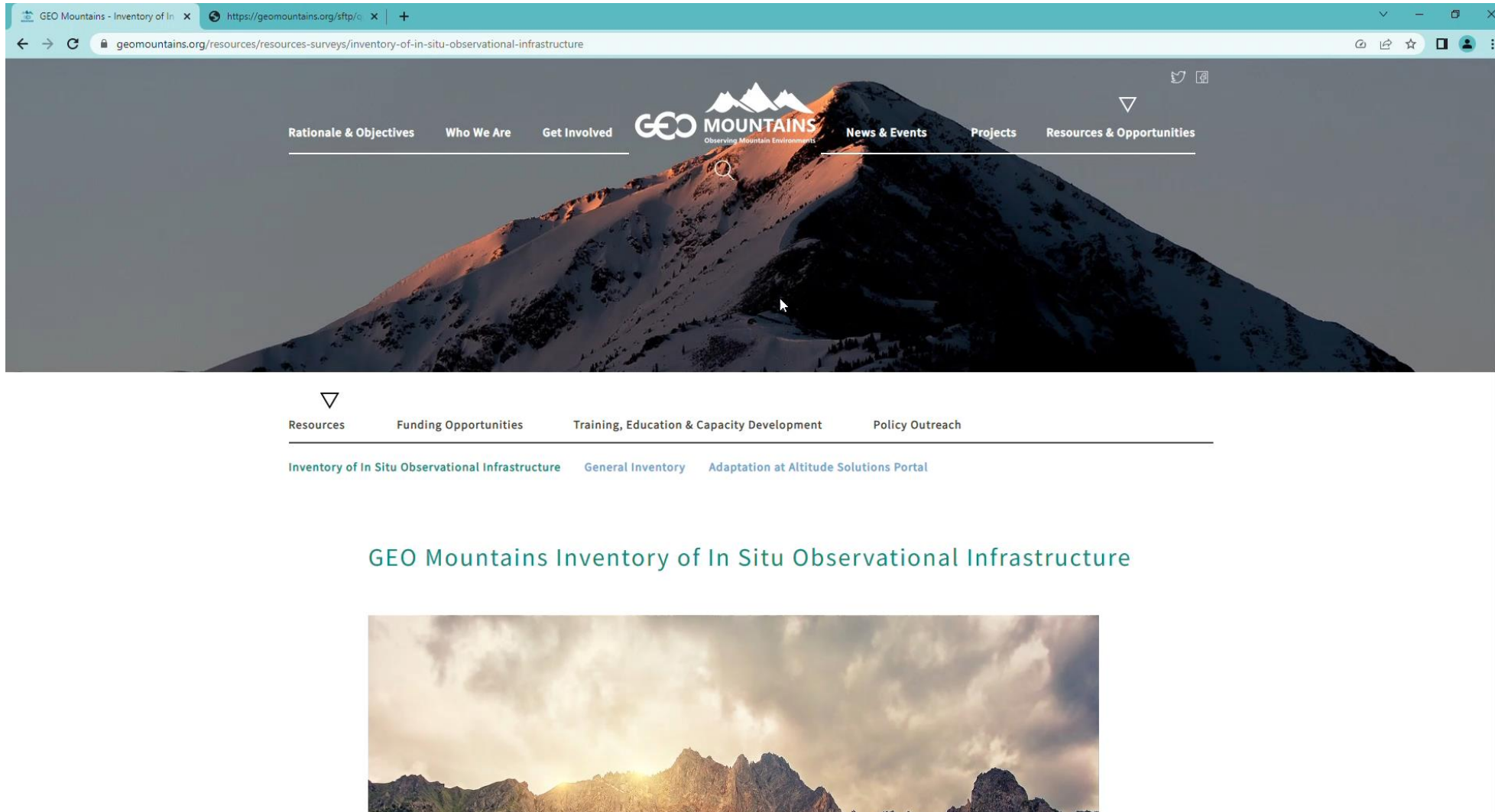
A Global Inventory of In Situ Mountain Observational Infrastructure



- ❑ A considerable proportion of mountain monitoring (across multiple disciplines) is conducted **by the research community**, rather than operational agencies
- ❑ In this **extremely heterogeneous “monitoring landscape”**, its extremely **hard to get a comprehensive overview** of **who** is measuring **what, where, when, how** and **why!**
- ❑ Potential **consequences**: Duplication / redundancy, inefficiently, undeveloped collaborations, etc.



A Global Inventory of In Situ Mountain Observational Infrastructure



<https://www.geomountains.org/resources/resources-surveys/inventory-of-in-situ-observational-infrastructure>

A Global Inventory of In Situ Mountain Observational Infrastructure



- Aims to provide a **comprehensive, multi-disciplinary overview** of in situ mountain monitoring
- Web-mapping application** and **dataset available for download**
- v2 contains **> 51,000** stations, networks, experimental basins, etc.
- Work still needed to **complete metadata** for many sites and ensure **access to / sharing of underlying data** (e.g. time-series)
- Could eventually provide the basis for a **comprehensive gap analysis**
- Please contribute your mountain sites!**

General Inventory



- A **searchable and downloadable** table of > 400 **gridded mountain datasets** (global, regional, & local), **data portals** that contain data pertaining to mountain regions, and other useful **tools / services**
- Aims to improve the **efficiency** of discovery and access **discovered**
- Again, please propose anything you would like to see included in v2!

General Inventory

Interactive table

Search:

a Level	Primary Theme	Secondary Theme(s)	Continent	Name	Version	Provider	URL
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>				
	Multiple		Africa	Africa GeoPortal		Regional Centre for Mapping of Resources for Development; Digital Earth Africa; NASA Earth Science; others	https://www.a
	Multiple		Europe	AlpEnDAC		Bavarian State Ministry of the Environment and Consumer Protection	https://www.a

Peer-reviewed publications



One Earth



Perspective Toward a definition of Essential Mountain Climate Variables

James M. Thornton,^{1,2,*} Elisa Palazzi,³ Nicolas C. Pepin,⁴ Paolo Cristofanelli,³ Richard Essery,⁵ Sven Kotlarski,⁶ Gregory Giuliani,^{7,8} Yaniss Guigoz,^{7,9} Aino Kulonen,¹ David Pritchard,⁹ Xiaofeng Li,¹⁰ Hayley J. Fowler,⁹ Christophe F. Randin,¹¹ Maria Shahgedanova,¹² Martin Steinbacher,¹³ Marc Zebisch,¹⁴ and Carolina Adler⁵

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⁵Federal Office of Meteorology and Climatology, MeteoSwiss, Dübendorf, Switzerland
⁶enviroSPACE, Institute for Environmental Science, University of Applied Sciences, Geneva, Switzerland
⁷GRID-Geneva, Science Division, UN Environment, Geneva, Switzerland
⁸School of Engineering, University of Newca
⁹Southern Marine Science and Engineering Natural Disaster Studies, School of Atmospheric and Oceanic Sciences, University of
¹⁰Department of Ecology and Evolution, University of Colorado Boulder, Boulder, Colorado, United States
¹¹Department of Geography and Environmental Science, University of Portsmouth, Portsmouth, United Kingdom
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<https://doi.org/10.1016/j.oneear.2021.05.001>

Mountain Research and Development (MRD)

An international, peer-reviewed open access journal published by the International Mountain Society (IMS)
www.mrd-journal.org

MountainAgenda

Target knowledge

Reviews of Geophysics*

REVIEW ARTICLE

10.1029/2020RG000730

Key Points:

- Using station and gridded data sets, we compare global precipitation and temperature trends by elevation

Climate Changes and Their Elevational Patterns in the Mountains of the World

N. C. Pepin¹, E. Arnone^{2,3}, A. Gobiet⁴, K. Haslinger⁴, S. Kotlarski⁵, C. Notarnicola⁶, E. Palazzi^{2,3}, P. Seibert⁷, S. Serafin⁸, W. Schönner⁹, S. Terzago¹, J. M. Thornton¹⁰, M. Vuille¹¹, and C. Adler¹⁰

Mountain Observatories: Status and Prospects for Enhancing and Connecting a Global Community

Maria Shahgedanova^{1,*}, Carolina Adler², Aster Gebrekirstos³, H. Ricardo Grau⁴, Christian Hugge⁵, Robert Marchant⁶, Nicholas Pepin⁷, Veerle Vanacker⁸, Daniel Viviroli⁹, and Mathias Vuille⁹

* Corresponding author: m.shahgedanova@reading.ac.uk

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PLOS ONE

RESEARCH ARTICLE

Human populations in the world's mountains: Spatio-temporal patterns and potential controls

James M. Thornton^{1,*}, Mark A. Snethlage², Roger Sayre³, Davnah R. Urbach², Daniel Viviroli⁴, Daniele Ehrlich⁵, Veruska Muccione⁴, Philippus Wester⁶, Gregory Insarov⁷, Carolina Adler¹

¹ Mountain Research Initiative, University of Bern, Bern, Switzerland, ² Global Mountain Biodiversity Assessment, University of Bern, Bern, Switzerland, ³ U.S. Geological Survey, Reston, VA, United States of America, ⁴ Department of Geography, University of Zurich, Zurich, Switzerland, ⁵ Joint Research Center, European Commission, Ispra, Italy, ⁶ International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal, ⁷ Institute of Geography, Russian Academy of Sciences, Moscow, Russia

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frontiers | Frontiers in Climate

ORIGINAL RESEARCH
published: 26 April 2022
doi: 10.3389/fcim.2022.814181



Coverage of *In Situ* Climatological Observations in the World's Mountains

James M. Thornton^{1*}, Nicholas Pepin², Maria Shahgedanova³ and Carolina Adler¹

¹ Mountain Research Initiative, University of Bern, Bern, Switzerland, ² School of the Environment, Geography and Geosciences, University of Portsmouth, Portsmouth, United Kingdom, ³ Department of Geography and Environmental Science, University of Reading, Reading, United Kingdom

Workshops



MRI Mountains Observatories Working Group and GEO Mountains Workshop in Central Asia

18/04/2023 — 20/04/2023 GEO Mountains Event

📍 Event location

Almaty, Kazakhstan



GEO Mountains Workshop: Interdisciplinary Monitoring, Data, and Capacity Sharing Across the Caucasus

05/07/2023 11:15 — 18:30 MRI Event

📍 Event location

Akaki Tsereteli Kutaisi State University
Library Building III, Floor II, Room 22-208
Kutaisi



Advancing the Concept of Essential Mountain Climate Variables (EMCVs)

28/04/2023 13:30 — 18:00 MRI Event

💰 Price information

Free

📍 Event location

Hotel Meliá Vienna
Donau-City-Straße 7
Vienna, 1220



Uniform High-Elevation Observing Platform (UHOP) Workshop

25/06/2023 — 27/06/2023 16:00 — 13:00

GEO Mountains Event

💰 Price information

Free

📍 Event location

Room A222, UniS
Schanzneckstrasse 1
Bern, 3012

Policy Brief on “Mountain Observations”



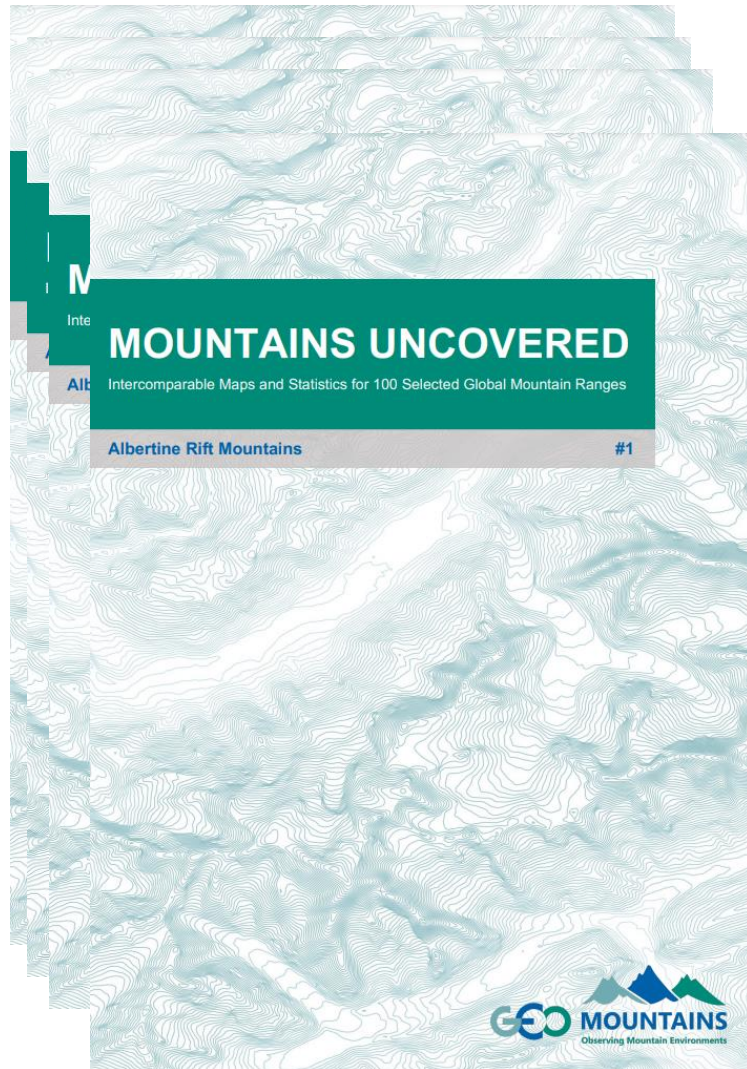
<https://www.geomountains.org/resources/outreach>

The Mountains Uncovered Series

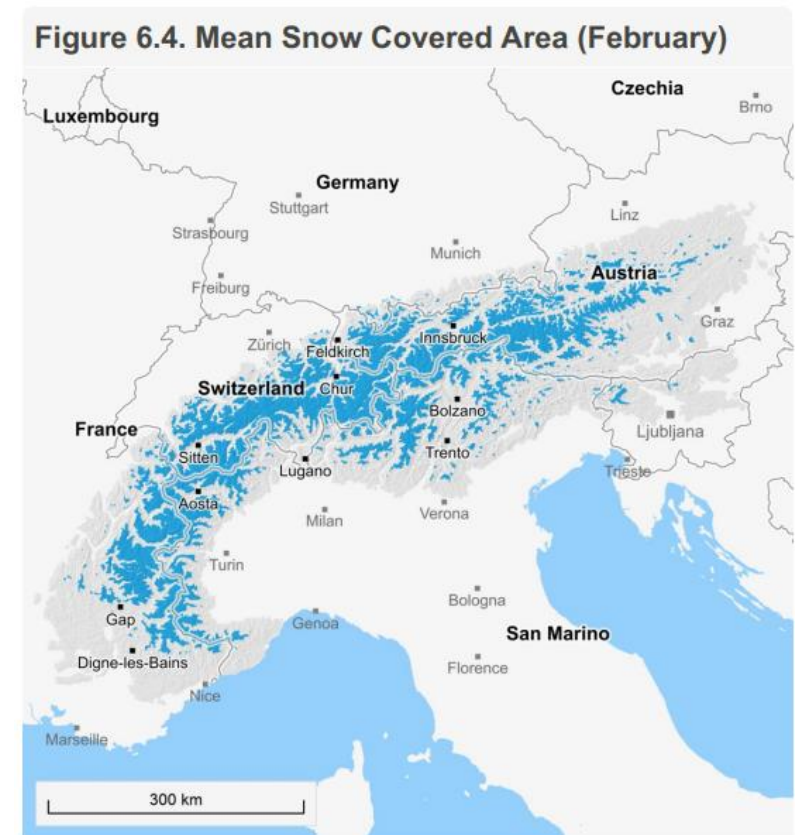
- ❑ High level fact booklets for 100 selected global mountain ranges
- ❑ As **inter-comparable** as possible (common datasets)



The Mountains Uncovered Series



× 100



GEO Mountains & Community Projects



GEO Mountains Projects Community Projects

Projects

IMPETUS: Turning Climate Commitments into Action



IMPETUS focuses on increasing our resilience. Working with local citizens, policy-makers, and businesses in demonstration sites around Europe, IMPETUS teams are analysing solutions, boosting knowledge, and creating packages of adaptation measures that other communities can use as a pathway towards a climate-neutral and sustainable future.

To help accelerate Europe's climate adaptation strategy and meet the European Union's ambitions to become the world's first climate-neutral continent by 2050, IMPETUS was launched in October 2021. Its objective is to turn climate commitments into tangible, urgent actions to protect communities and the planet.

community.

[READ MORE →](#)

Taskforce for the Review of the SDG Indicator 15.4.2 - Mountain Green Cover Index (2021 - Present)



The 2030 Agenda for Sustainable Development provides a shared blueprint for peace and prosperity for people and the planet. At its heart are the 17 Sustainable Development Goals (SDGs), among them SDG 15 Life on Land, which includes indicator 15.4.2 - the Mountain Green Cover Index (MGCI). In 2021, as the UN agency custodian for the MGCI, the Food and Agriculture Organization of the United Nations (FAO) set up a Taskforce for the review of the MGCI. The Taskforce convenes key member countries and stakeholders to provide technical advice, and includes the GEO Mountains

community.

The SDG Indicator 15.4.2 - Mountain Green Cover Index (MGCI) is one of the two indicators under SDG Target 15.4, which aims to "ensure the conservation of mountain ecosystems, including their biodiversity, to enhance their capacity to provide benefits which are essential for sustainable development". The MGCI measures changes in the area of green cover in mountain areas. These changes are reported as the change of the proportion of the area covered by four land cover/land use classes (forest, grassland, croplands and wetlands) over time. This figure is expressed as a percentage of the total mountain area and is disaggregated by mountain and land cover and land use classes, following the UNEP-IGBP and IPCC classifications, respectively. The MGCI is based on the assumption that green cover is directly correlated with the health state of mountain ecosystems. Further information on the methodology of the existing version of the MGCI can be found in the SDG Indicator 15.4.2 metadata.

[READ MORE →](#)

Analysing the Coverage of In Situ Observations in the World's Mountains (2021 - Present)



In situ climatological and other data from the world's mountains are crucial for many applications. It follows that any limitations associated with the coverage of such data (e.g. limited spatial density of stations, short record lengths, lack of observations at higher elevations, etc.) can impinge upon several important activities, not least tracking ongoing change in mountain climates and reliably projecting future changes and their impacts.

Despite this situation, the fundamental coverage of in situ data coverage with respect to space, time, and elevation has not yet been comprehensively assessed globally. As such, comparing data coverage across different mountain regions, for instance, is impossible. Yet it is precisely this information that international organisations and other stakeholders require if they are able to make sound informed decisions around investing in new (and maintaining existing) in situ monitoring efforts.

[READ MORE →](#)

GEO Mountains Projects Community Projects

Community Projects

African Mountain Research Foundation



The beautiful, biodiversity-rich mountain systems of the Southern African Development Community (SADC) region provide vital water catchment services for the region's fast-growing population. But climate change, alien invasive species and over-grazing are degrading these mountains and making it harder for them to act as water towers for lowland agriculture, towns and cities. If action isn't taken now the consequences could be catastrophic for hundreds of millions of people.

African Mountain Research Foundation is a UK registered charity set up to help safeguard these fragile mountain systems by enhancing field research, supporting landscape conservation and restoration programmes, and improving national and regional policy-making.

[READ MORE →](#)

SoilTemp



SoilTemp is a global network building a database of microclimate time series and associated biodiversity data for use in ecology. GEO Mountains is supporting this initiative to increase the global coverage of microclimate monitoring in mountain regions across the globe. See here for an update on recent progress.

[READ MORE →](#)

Community Snow Observations (CSO)



CSO is a NASA-funded citizen science campaign to measure snow. The project aims to improve our understanding of snow depth variability in mountainous regions.

We need community-based observers, including backcountry professionals and recreationalists, to help gather snow observations. "On the ground" measurements and interpretations of satellite and airborne snow measurements collected by NASA and other agencies.

[READ MORE →](#)

Canadian Mountain Assessment



The Canadian Mountain Assessment (CMA) is advancing an innovative, made-in-Canada approach to knowledge assessment that brings together Indigenous and Western ways of knowing to address three fundamental questions: what do we know, not know, and need to know about Canada's diverse and rapidly changing mountain systems?

The final assessment report will provide a first-of-its-kind look at the state of knowledge of Canada's mountains, including the relative scope of knowledge across topics and geographies, based on diverse lines of evidence. The CMA provides a platform for connecting and mobilising researchers, practitioners, and Indigenous Peoples with knowledge of mountains, and is therefore also helping to catalyse a community of practice related to mountains in Canada.

<https://www.geomountains.org/projects-impact-stories/ongoing-projects>

Education / Capacity Sharing



MOUNTAIN SUSTAINABILITY MATERIALS

Suggested citation & License:

Allchin, M.I., Warren, M. & Williamson, S.N. (2022). Mountain Sustainability Education Program, v1. Sea to Sky Gondola, Mountain Research Initiative, GEO Mountains, University of Calgary & Arctic Institute of North America.

The course materials are issued under the [CC BY-NC Attribution NonCommercial 4.0 International licence](https://creativecommons.org/licenses/by-nc/4.0/).

Introduction & Acknowledgments

The Mountain Sustainability Education Program, a collaboration between Sea to Sky Gondola, Mountain Research Initiative, GEO Mountains, the University of Calgary, and the Arctic Institute of North America, provides a set of teaching resources designed for learners of all ages. The materials were developed by Michael Allchin, Martha Warren, and Scott Williamson.

Educators from around the world are free to use, adapt and further develop the course materials, in accordance with the license specified. Please kindly inform us by writing to education@seatoskygondola.com. Any feedback can also be sent to this address. If you extend the course (e.g. prepare region-specific case studies, cover additional topics etc.) and would like us to consider including this material in subsequent updates, please do not hesitate to get in touch.

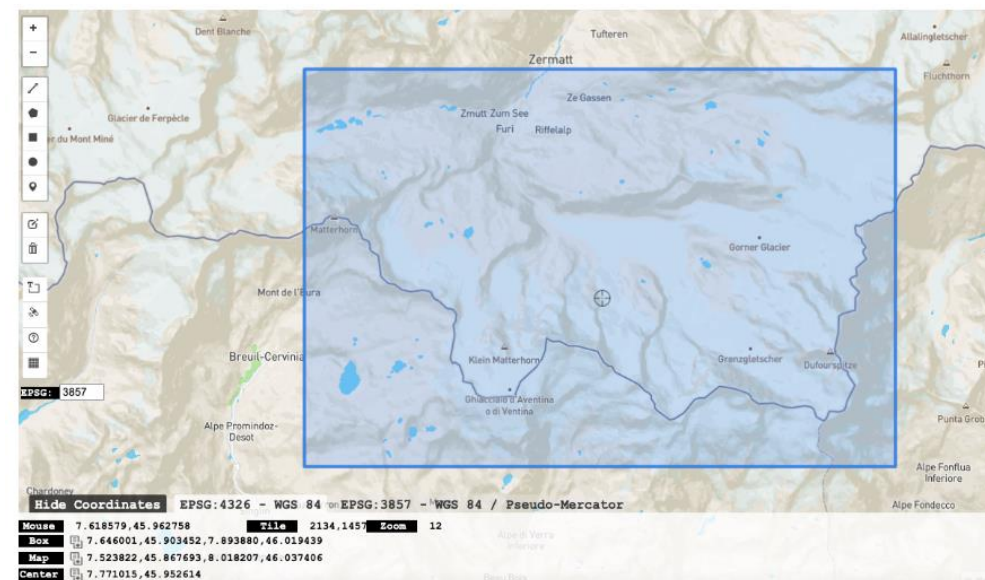


Efficient zonal statistics over complex geometries using PostGIS

James M. Thornton, Mountain Research Initiative (MRI), c/o University of Bern, Switzerland
(james.thornton@unibe.ch)

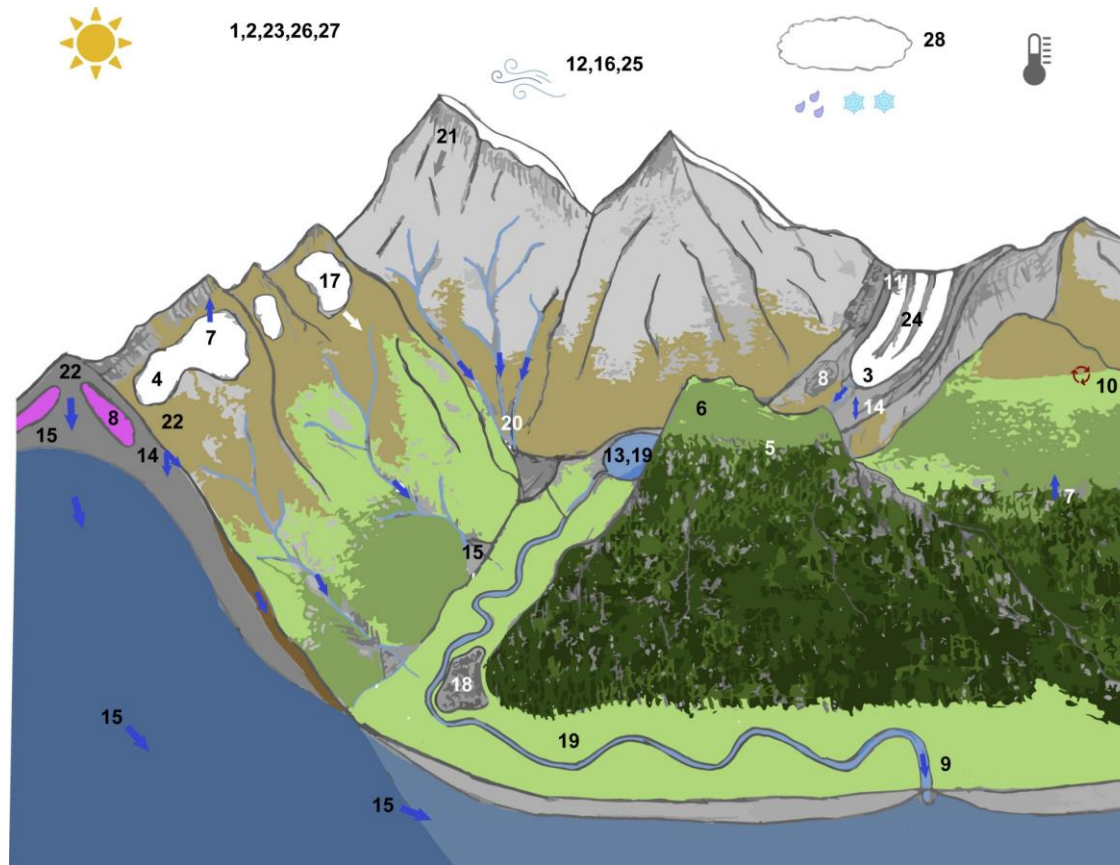
15 June 2023

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GEO Mountains Post-2025

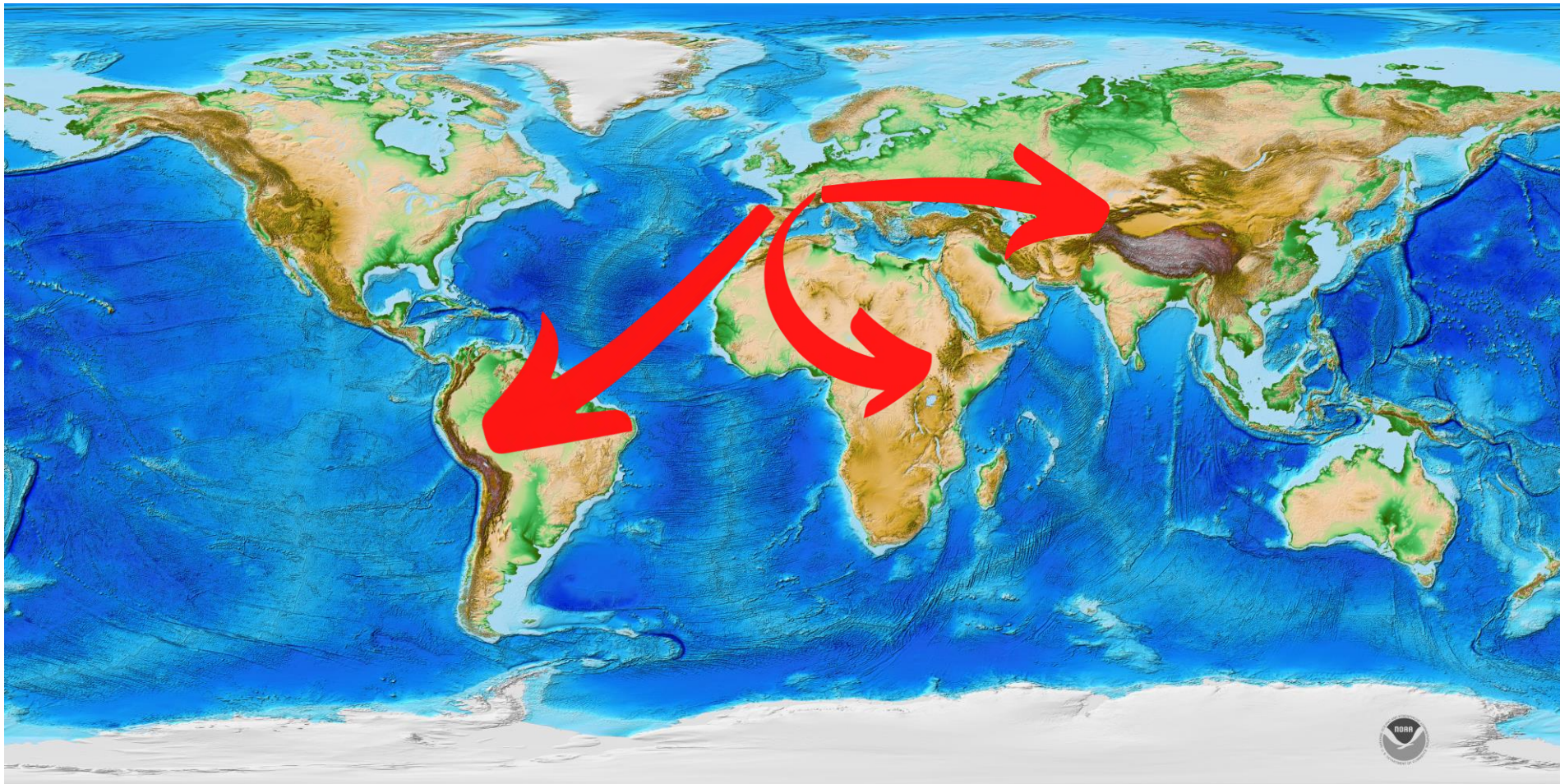
Mountains as “**natural integrators**” (multiple disciplines; globally distributed regions)? > Could GEO Mountains lead / be one of the major contributors to a dedicated multi-disciplinary programme / nexus on mountains?



“There is a clear need for a global partnership where data providers and users from all communities work together, leading to better coordination, greater inclusion, reduced duplication, and faster action”

Enhanced transfer of knowledge & technologies from Europe to other global mountain regions

“we must actively co-produce meaningful resources that address contemporary challenges”



Many thanks!

geomountains@mountainresearchinitiative.org