MOUNTAIN RESEARCH INITIATIVE

The mountain cryosphere in a changing climate: a view from within science-policy

Carolina Adler, PhD
MRI Executive Director

7 February 2023 I 10th EARSeL workshop on Land Ice and Snow I University of Bern, Switzerland

www.mountainresearchinitiative.org

Supported by
scnat
swiss academy of sciences

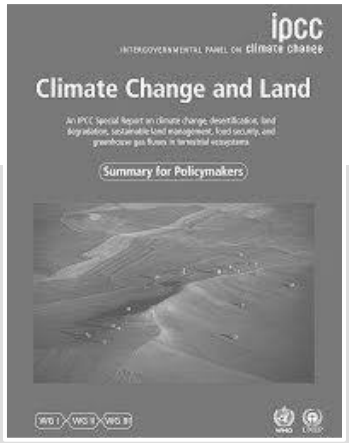
IPCC AR6

2019 SROCC: Chapter 2 “High Mountain Areas”

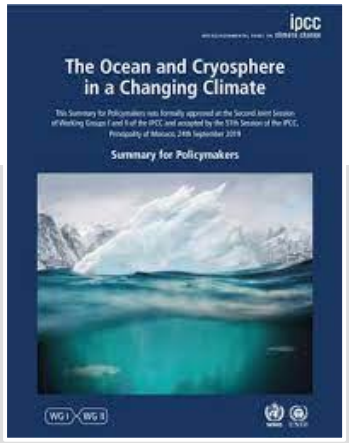
2022 WGII AR6: Cross-Chapter Paper: Mountains

October 2018

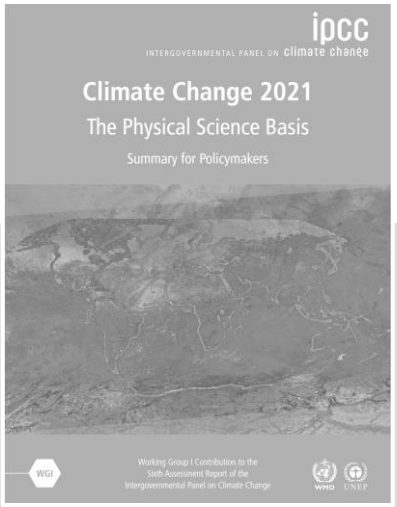
August 2019



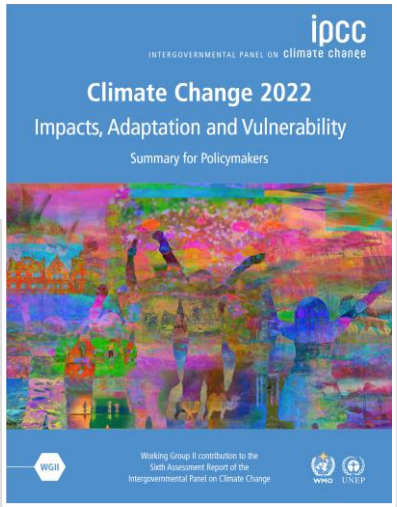
September 2019



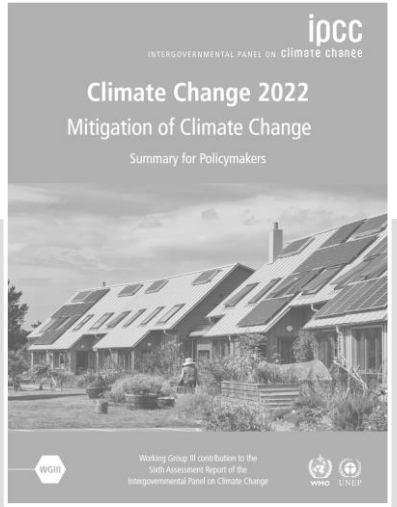
August 2021



February 2022



March 2022



Expected: March 2023

Report by numbers AR6 WGII (CCP5)

270 (8) Authors

67 (10) Countries

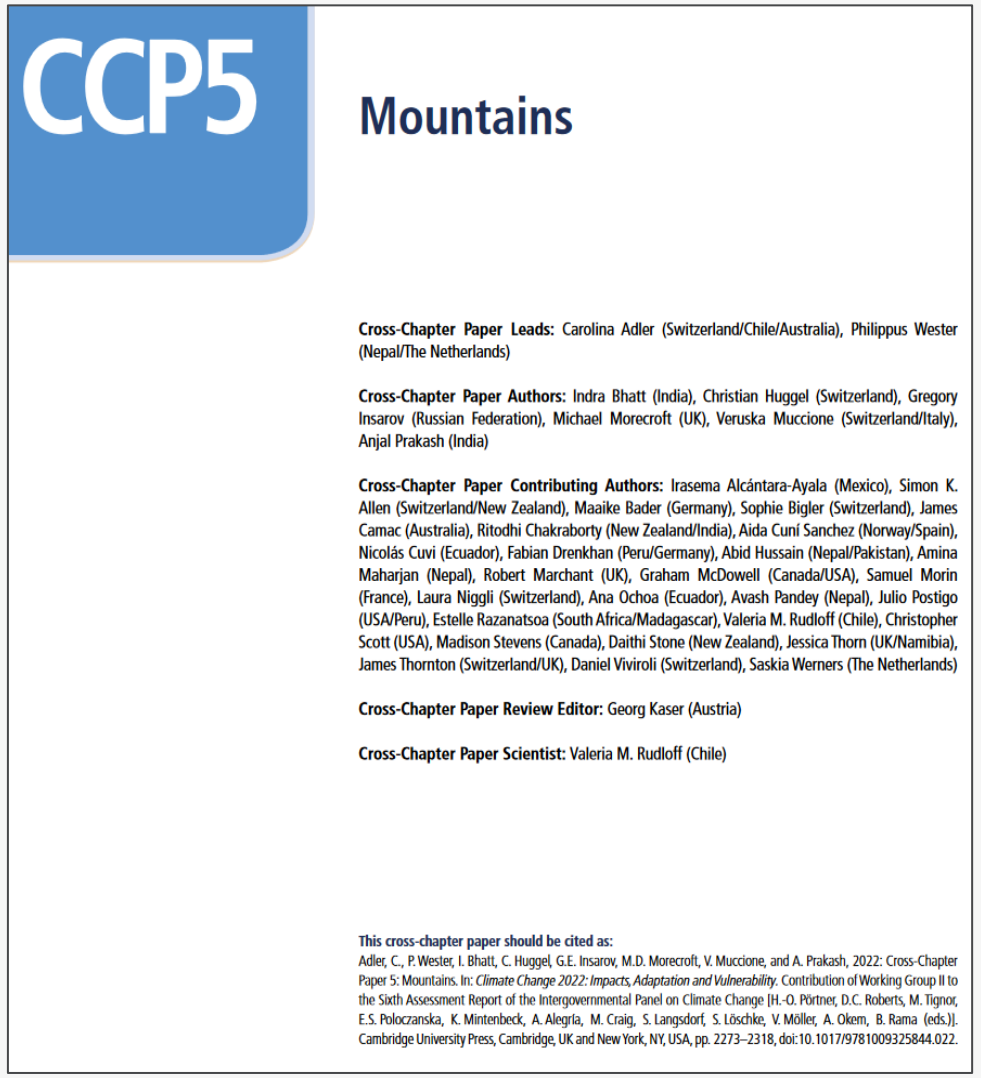
43% (20%) Developing countries
57 % (80%) Developed countries

41% (25%) Women
59% (75%) Men

675 (27) Contributing authors

More than
34,000 (533) scientific papers

62,418 (2,083)
Review comments


CCP5

Mountains

Cross-Chapter Paper Leads: Carolina Adler (Switzerland/Chile/Australia), Philippus Wester (Nepal/The Netherlands)

Cross-Chapter Paper Authors: Indra Bhatt (India), Christian Huggel (Switzerland), Gregory Insarov (Russian Federation), Michael Morecroft (UK), Veruska Muccione (Switzerland/Italy), Anjal Prakash (India)

Cross-Chapter Paper Contributing Authors: Irasema Alcántara-Ayala (Mexico), Simon K. Allen (Switzerland/New Zealand), Maaike Bader (Germany), Sophie Bigler (Switzerland), James Camac (Australia), Ritodhi Chakraborty (New Zealand/India), Aida Cuní Sanchez (Norway/Spain), Nicolás Cuvi (Ecuador), Fabian Drenkhan (Peru/Germany), Abid Hussain (Nepal/Pakistan), Amina Maharjan (Nepal), Robert Marchant (UK), Graham McDowell (Canada/USA), Samuel Morin (France), Laura Niggli (Switzerland), Ana Ochoa (Ecuador), Avash Pandey (Nepal), Julio Postigo (USA/Peru), Estelle Razanatsoa (South Africa/Madagascar), Valeria M. Rudloff (Chile), Christopher Scott (USA), Madison Stevens (Canada), Daithi Stone (New Zealand), Jessica Thorn (UK/Namibia), James Thornton (Switzerland/UK), Daniel Viviroli (Switzerland), Saskia Werners (The Netherlands)

Cross-Chapter Paper Review Editor: Georg Kaser (Austria)

Cross-Chapter Paper Scientist: Valeria M. Rudloff (Chile)

This cross-chapter paper should be cited as:
Adler, C., P. Wester, I. Bhatt, C. Huggel, G.E. Insarov, M.D. Morecroft, V. Muccione, and A. Prakash, 2022: Cross-Chapter Paper 5: Mountains. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 2273–2318, doi:10.1017/9781009325844.022.

https://www.ipcc.ch/report/ar6/wg2/downloads


[Damian Markutt – Unsplash]


[Prateek Katyt – Unsplash]


[Xavier von Erlach – Unsplash]

Observed climate change and impacts in mountain regions

- **Climate change impacts**, and their attribution to human influence, **have increased** in many mountain regions – with serious consequences for people and ecosystems.
- **Two-thirds of irrigated agriculture depends on water from mountains**. Changes in water availability are specially impacting seasonally dry regions.
- Seasonal changes negatively affect tourism (e.g., snow-dependent winter activities).
- **Exposure to climate-related hazards**, e.g., (flash floods) and landslides, are **contributing to an increase in disasters** affecting a growing number of people in mountain regions and further downstream.

Source: CCP5-Mountains (Adler *et al*., 2022)

Photo Vivek Sharma/unsplash

> Increasing temperatures will continue to induce changes in mountain regions throughout the 21st century, with expected negative consequences for mountain cryosphere, biodiversity, ecosystem services and human well being (*very high confidence*) {CCP5.3.1}

Projected impacts at 1.5°C and beyond

- Low elevation and small glaciers will lose most of their total mass at 1.5°C GWL.
- In tropical and mid-latitude mountains, 50% ice volume lost under low-emission scenarios, but two-thirds to more than 90% lost under high-emission scenarios by 2100.
- Strongest impacts in glacier and snowmelt dependent regions, e.g., Central Asia, South Asia, western South America and southwestern North America
- A large majority of endemic mountain species (up to 84%) will be at increasing risk of extinction beyond 1.5°C (even under overshoot).

CCP5.3, SPM.B.4.2, SPM.B.6.1

Photo: Danny Postma, Unsplash

Key risks assessment - four key risks in mountains

1. Loss of lives, harm to people, and damages to infrastructures from hazards such as **landslides and floods**.

2. Adverse impacts to livelihoods and risks to economic sectors, both for mountain communities and in the lowlands, from **changes in water availability** and its management.

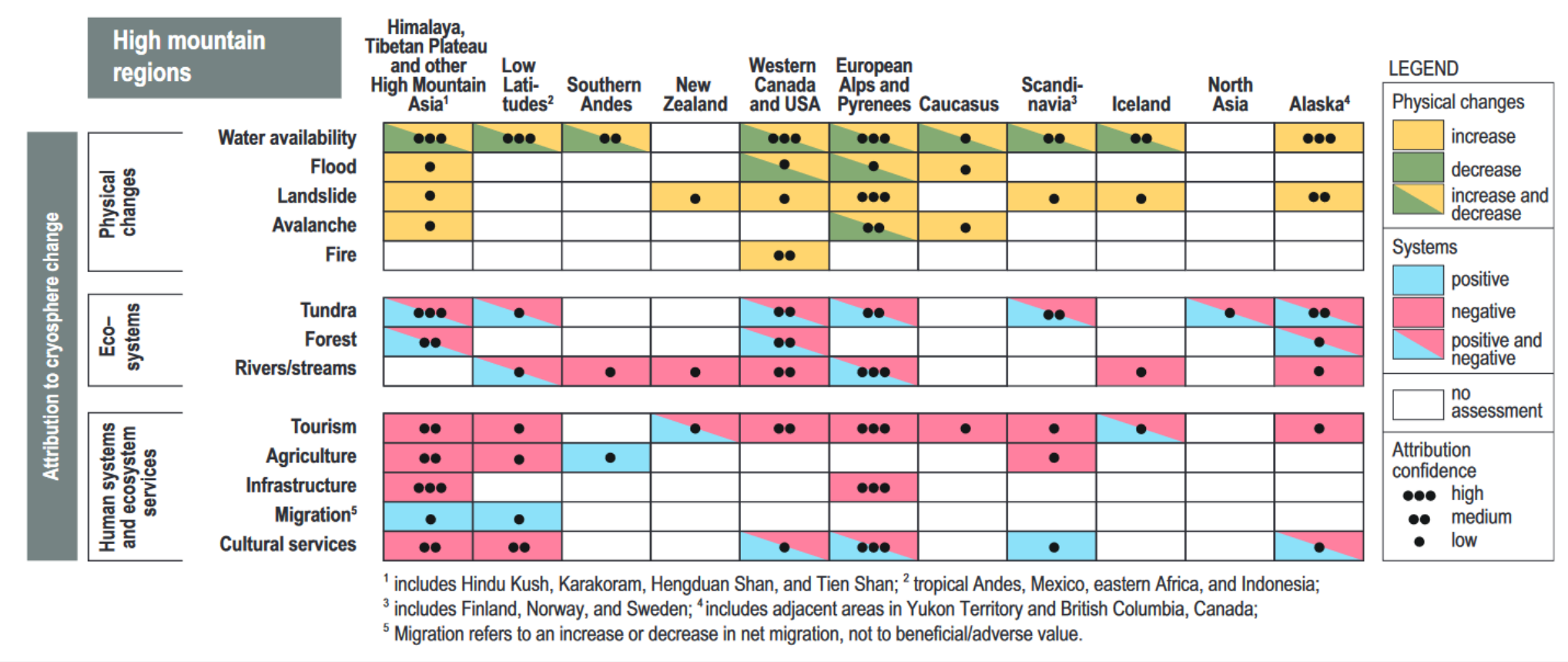
3. Changes to **mountain ecosystems** and risks of mountain top species extinction.

4. **Intangible losses and harm** to people and loss **of cultural values** from decline of ice, snow cover and warming as well as increase in disasters.

Source: CCP5.3.2 (Adler *et al,* 2022)

Key gaps - SROCC

- Detection and attribution of atmospheric drivers that influence climate-related changes - including radiative forcing effects of light absorbing particles and their spatiotemporal dynamics (regional feedbacks).



SROCC Figure 2.8 (Hock *et al*, 2019)

Key gaps - SROCC

- Detection and attribution of atmospheric drivers that influence climate-related changes - including radiative forcing effects of light absorbing particles and their spatiotemporal dynamics (regional feedbacks).

SROCC Figure 2.8 (Hock *et al*, 2019)

Key gaps - SROCC

- Detection and attribution of atmospheric drivers that influence climate-related changes - including radiative forcing effects of light absorbing particles and their spatiotemporal dynamics (regional feedbacks).
- Distribution and characteristics of cryospheric variables - extent and ice content of permafrost in mountains, glacier ice volumes, trends in lake and river ice, and the spatial and temporal variation of snow cover ... despite wealth of EO data since AR5.
- Projections of future climate change trends at high elevations (complex topography and high relief). Improved cross-disciplinary exchange on observations and modelling approaches needed.
- Experiences with changes in water availability, and with changes in frequency and/or magnitude of natural hazards - lack of comprehensive risk approaches to systematically characterise and compare magnitude and extent of past impacts and future risks - including compound risks and cascading impacts.
- Adaptation - systematically evaluating cost-benefits and long-term effectiveness as 'fit-for-purpose' solutions in the mountain context (e.g. EWS).

Source: SROCC 2.5 (Hock *et al,* 2019)

Key gaps - SROCC

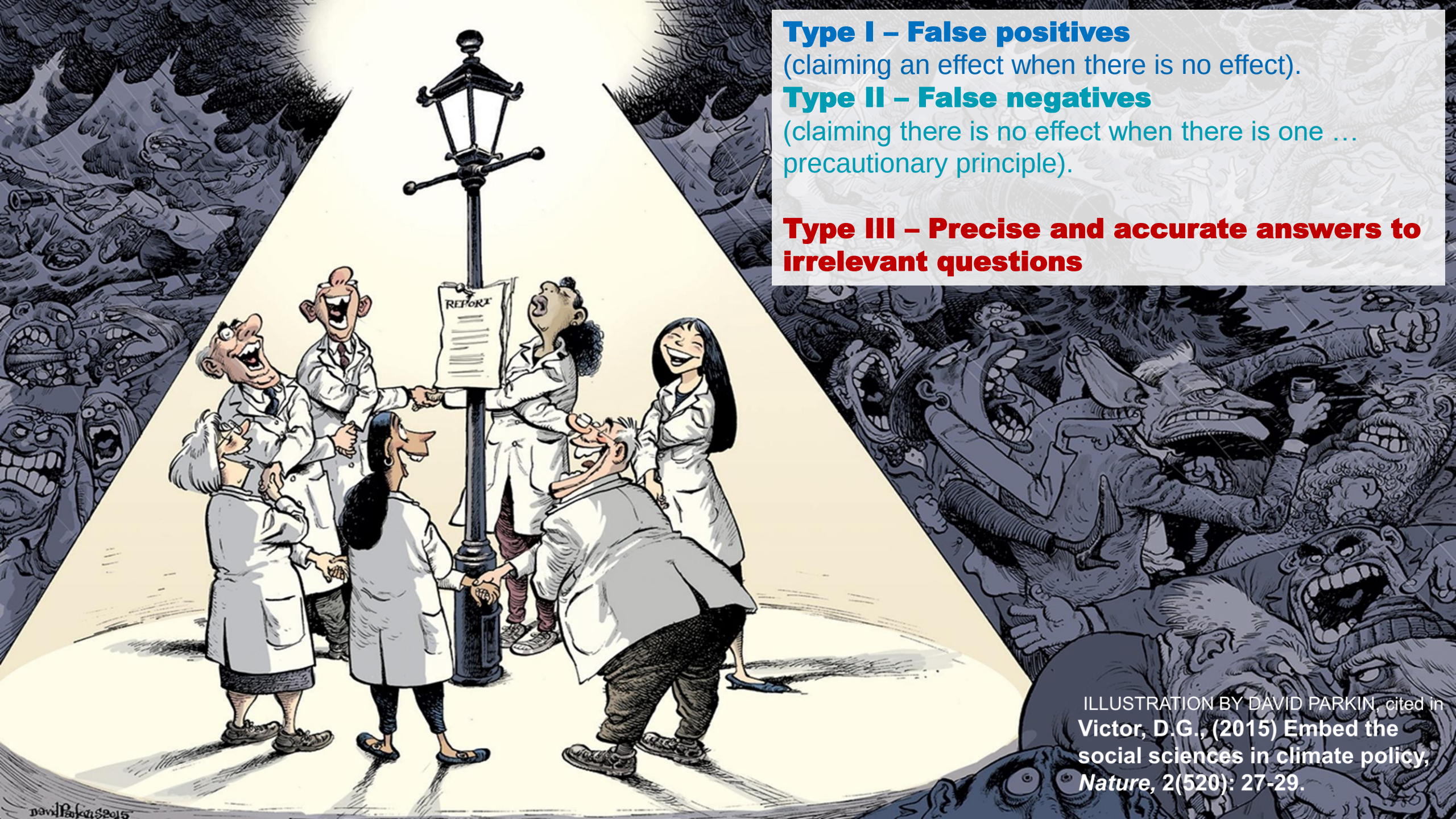
- Detection and attribution of atmospheric drivers that influence climate-related changes - including radiative forcing effects of light absorbing particles and their spatiotemporal dynamics (regional feedbacks).
- Distribution and characteristics of cryospheric variables - extent and ice content of permafrost in mountains, glacier ice volumes, trends in lake and river ice, and the spatial and temporal variation of snow cover ... despite wealth of EO data since AR5.
- Projections of future climate change trends at high elevations (complex topography and high relief). Improved cross-disciplinary exchange on observations and modelling approaches needed.
- Experiences with changes in water availability, and with changes in frequency and/or magnitude of natural hazards - lack of comprehensive risk approaches to systematically characterise and compare magnitude and extent of past impacts and future risks - including compound risks and cascading impacts.
- Adaptation - systematically evaluating cost-benefits and long-term effectiveness as 'fit-for-purpose' solutions in the mountain context (e.g. EWS).

Source: SROCC 2.5 (Hock *et al,* 2019)

Key gaps – WGII (CCP5)

- Detection and attribution of observed impacts to climate change.
- Limitations and uncertainties associated with predictive models of projected impacts and risks:
  - *Understanding of future vulnerabilities in mountain social-ecological systems in relation to highly variable and dynamic trends in projected demographic change, socioeconomic development pathways and demand for resources.*
  - *Species distribution models (SDM).*
- Integrated and systems-oriented research on mountain ecosystem services and their limits under climate change.
- Measurable tracking of adaptation action implemented in mountain regions and their suitability for addressing climate risks.
  - *Feasibility and suitability of adaptation options for managing climate risks – esp. with GWL above 1.5^{o}C.*

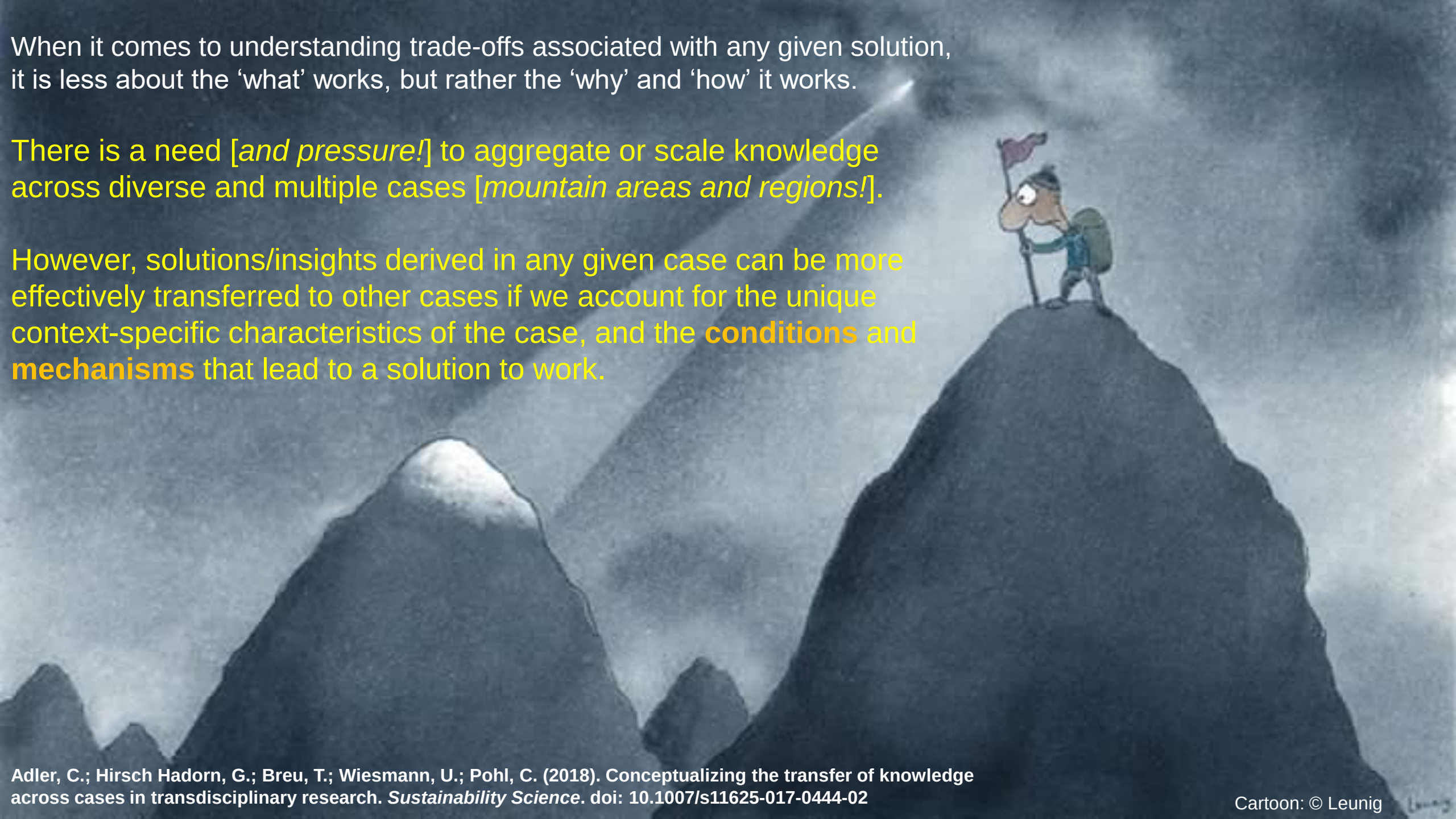
Source: CCP5.5 (Adler *et al,* 2022)



Type I – False positives
(claiming an effect when there is no effect).
Type II – False negatives
(claiming there is no effect when there is one … precautionary principle).

Type III – Precise and accurate answers to irrelevant questions

ILLUSTRATION BY DAVID PARKIN, cited in
Victor, D.G., (2015) Embed the social sciences in climate policy, *Nature*, 2(520): 27-29.



When it comes to understanding trade-offs associated with any given solution, it is less about the ‘what’ works, but rather the ‘why’ and ‘how’ it works.

There is a need [*and pressure!*] to aggregate or scale knowledge across diverse and multiple cases [*mountain areas and regions!*].

However, solutions/insights derived in any given case can be more effectively transferred to other cases if we account for the unique context-specific characteristics of the case, and the **conditions** and **mechanisms** that lead to a solution to work.

Adler, C.; Hirsch Hadorn, G.; Breu, T.; Wiesmann, U.; Pohl, C. (2018). Conceptualizing the transfer of knowledge across cases in transdisciplinary research. *Sustainability Science*. doi: 10.1007/s11625-017-0444-02

UNFCCC COP 27 experiences & opportunities

Version 8.11.2022

11. The SBSTA emphasized the need to address observation gaps, particularly in developing countries and ocean, high-mountain and polar regions, in order to improve understanding of climate change, climate-related risks and tipping points, and ensure enhanced delivery of climate services and early warning systems.

View of the room during informal consultations on research and systematic observation. Photo: @IISD ENB

Decision -/CP.27
Implementation of the Global Climate Observing System ➔

3. *Emphasizes* the need to address systematic observation gaps, particularly in developing countries and for ocean, mountain, desert and polar regions and the cryosphere in order to improve understanding of climate change, climate-related risks and tipping points, and adaptation limits and to ensure enhanced delivery of climate services and early warning systems;

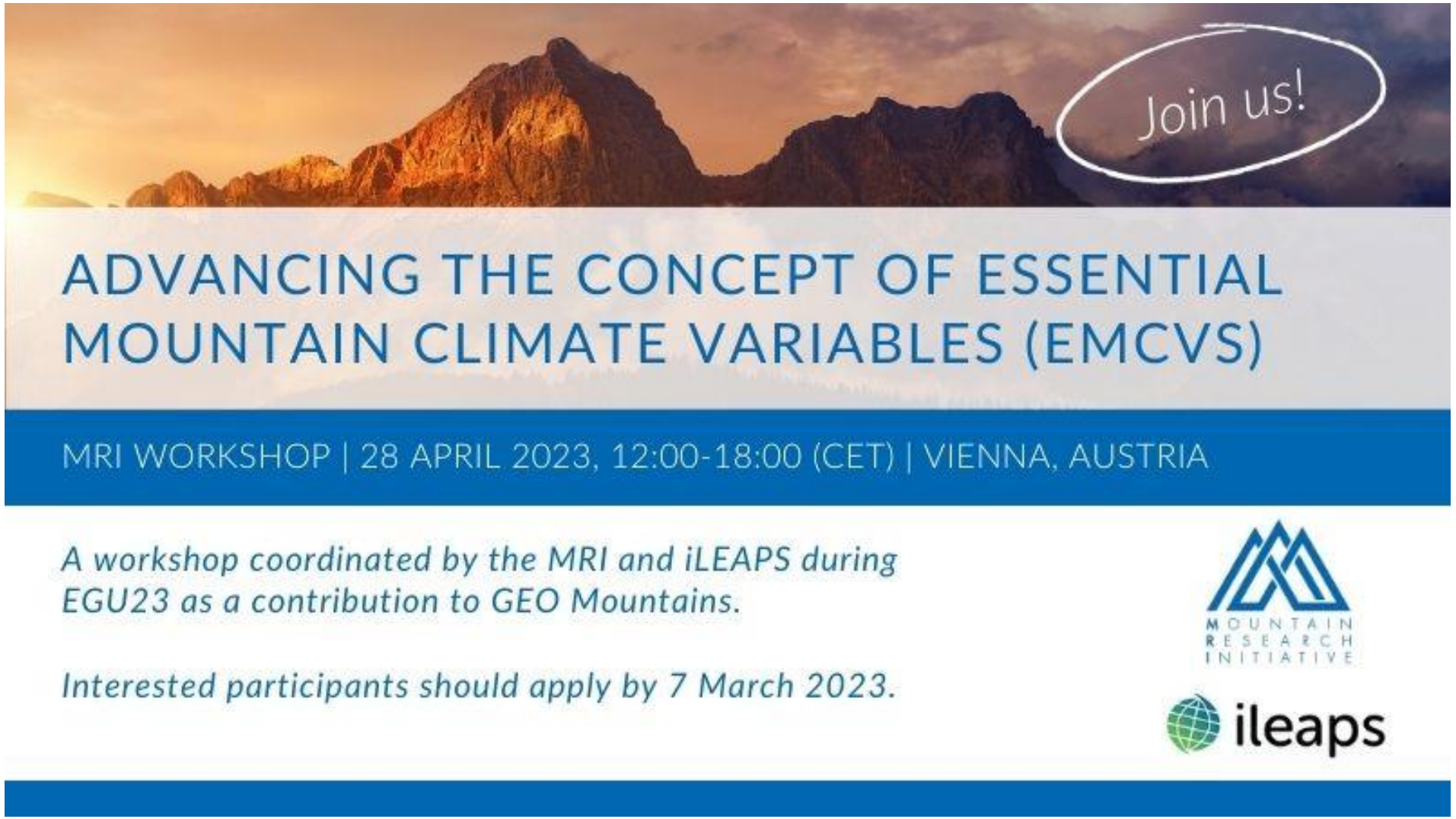
4. *Notes* with concern the existing gaps in the global climate observing system and *recognizes* the need to enhance the coordination of activities by the systematic observation community and improve its ability to provide useful and actionable climate information for mitigation, adaptation and early warning systems, as well as information to enable understanding of adaptation limits and of attribution of extreme events.

Opportunities ➔

UNGA 77th Session (December 2022) ➔

1. *Decides* to declare 2025 the International Year of Glaciers' Preservation and to proclaim 21 March of each year the World Day for Glaciers, to be observed starting in 2025;

IPCC Seventh Assessment cycle

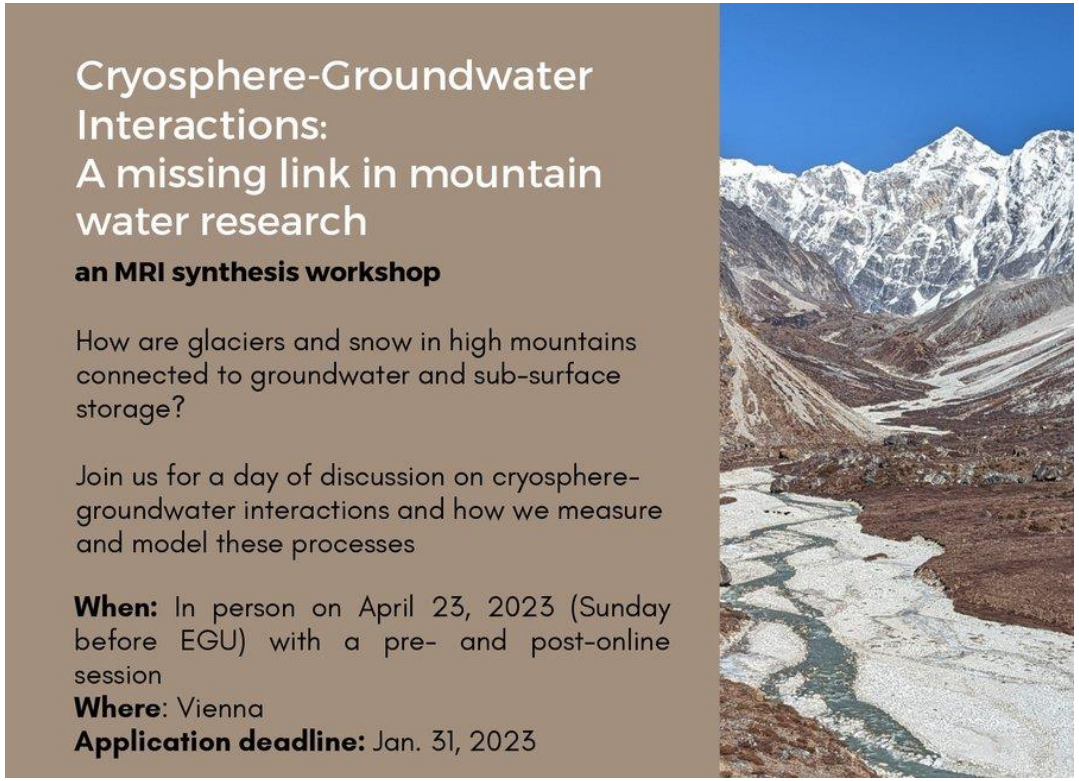


https://www.geomountains.org/news/events/details/2023-04-28/330-advancing-the-concept-of-essential-mountain-climate-variables-emcvs

Joint Body on the status of the mountain snow cover (SMSC)

(2022 – 2025)

https://cryosphericsciences.org/activities/jb-status-mountain-snow-cover/



https://www.mountainresearchinitiative.org/events/details/2023-04-23/544-cryosphere-groundwater-interactions-a-missing-link-in-mountain-water-research

Key take aways

- **Relevance** - Key knowledge **gaps** reported in the most recent IPCC assessment reports provide useful guidance on **assessment-relevant knowledge**.
- **Engagement** - In addition to (primary) research funding, look out for (funding) opportunities to **engage in review and synthesis research activities** … many research coordination networks can provide for this type of support (currently under-utilised!).
- **Timing** - is of the essence! Don’t miss key deadlines / milestones / opportunities to ensure contributions count when they are actually needed.


Cartoon: © Leunig

www.mountainresearchinitiative.org

Carolina Adler – mri@mountainresearchinitiative.org