Focus Issue: Innovation Pathways to Sustainability in Mountains

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Focus Issue: Innovation Pathways to Sustainability in Mountains

Dear Readers,

Fostering a better understanding of the nature, processes, and impacts of innovation in mountain areas around the world could not be a more timely aim. Over the course of just a few years, a number of simplified mountain narratives have emerged in the context of events garnering international attention. In early 2022 (the International Year of Sustainable Mountain Development!), the launch of the Russian Federation's military aggression against the people of Ukraine and the country's infrastructures unleashed a global energy crisis. Since then, politicians and scientists alike have intensified the framing of mountains as a source and storage of clean energy servicing the energy transition (eg Kunzig 2024). In the spring of 2025 (the International Year of Glaciers' Preservation!), the disappearance of the Swiss alpine village of Blatten under rock and ice debris following the disintegration of the Birch glacier prompted many politicians and scientists in the country to portray its mountain regions as places where the "retreat of civilization" should be envisaged as a legitimate way to cope with the increasing dangers and costs of climate change (eg Balzli 2025).

Both of these narratives, which are not the only ones, have a link to innovation: technological innovation in the case of the mountains-as-battery trope, institutional innovation in the form of adaptive capacity (or managed retreat) in the case of the mountains-as-hazard trope. They also gloss over nuances and differentiations in our "patchy Anthropocene" (Tsing et al 2024). Not all mountain regions are suitable for clean energy production: for example, the destruction in 2021 of two hydropower projects and the death of more than 200 people in Chamoli district of Uttarakhand prompted scientists to raise questions about clean energy development in the Himalaya and other high-mountain environments (Shugar et al 2021), reinforcing calls by the International Energy Agency and scientists to focus on innovation in low-energy demand before or alongside infrastructure investment (Nemet and Greene 2022). Similarly, not all places in mountains are imminently at risk from the consequences of climate change and various forms of innovation, widely reported in this journal, make countless mountain regions livable places (Adler et al 2022). Above all, these tropes underplay and deprive individuals and organizations in mountains of the very agency that innovation fundamentally depends on.

Accordingly, in this MRD *focus issue, we propose to consider innovation as a multidimensional and context-specific concept that can refer to an ambition, practice, discourse, or outcome. We have invited contributions that critically examine how socioeconomic, institutional, technological, scientific, and other types of innovation are of specific relevance to promoting or undermining sustainable development in mountains, thus taking to task the simplified narratives of innovation.*

Often framed as the key to solving social and environmental challenges, innovation has become a central idea in science, policy, and practice aimed at building a more sustainable world, including in mountain areas. However, this mainstream view still equates innovation primarily with technological advancement, continued economic expansion, and the promise of reduced ecological impact. While new ways of thinking and doing are definitely needed to respond to the environmental and socioeconomic crises that many mountain regions are facing—and while some of these "new ways" are in fact age-old practices developed over centuries or millennia, as repeatedly shown in work published in MRD*—a more nuanced examination of the concept of innovation is needed. In the STEPS Centre publication* Innovation, Sustainability, Development: A New Manifesto*, for example, the authors argue that meeting interlinked global challenges requires fostering "more* diverse *and far more fairly* distributed *forms of—and* directions *for—innovation, towards greater social justice" (STEPS Centre 2010: 2; emphasis in original).*

Because of their specific social–ecological conditions, mountain regions offer distinctive opportunities for generating new knowledge about innovation. On the one hand, innovation in the sense of continuous adaptation to unstable conditions often characterized by marginalization, vulnerability, and material scarcity has always been both a virtue and a necessity; of late, this has been exacerbated by mountain regions' disproportionate exposure to the consequences of global climate change. On the other hand, these very same conditions have regularly served to legitimize the promotion of innovation from outside, by state and nonstate actors alike; one need only consider the reaction of the anthropologist Werner Bellwald (2025), resident of the hamlet of Wiler that disappeared alongside Blatten in Switzerland, suggesting that federal and cantonal politicians were in greater need of "professional help" than the local residents.

By making the capacity to adopt exogenous forms of innovation a primary condition for access to economic or other support, policies have, paradoxically, often reinforced rather than reduced socioeconomic and territorial inequalities. In response, many scientists, practitioners, and policymakers have turned their attention to new understandings and forms of innovation, sometimes with an interest in mountain regions (eg Chandy et al 2012). One approach has involved a critique of theories that prioritize the diffusion of innovation, including their tendency to disregard the interrelationship between the technical components and the social environment; to separately analyze innovators and users; and to neglect the local dynamics of adoption. Scholarship in this tradition includes different strands more or less closely associated with actor–network theory as proposed, among others, by Michel Callon (1987), Madeleine Akrich (1992), and Bruno Latour (2007).

The notion that innovation must always involve novelty and be evaluated by how widely it is adopted has been questioned by an alternative strand of research. Scholars such as Frédéric Goulet and Dominique Vinck (2012) have explored the notion of "innovation by retreat," whether by removal, renunciation, or evacuation. In mountain regions or coastal areas, work on strategic, managed retreat is one example, even if the virulent reactions to the post-Blatten mountains-as-hazard narrative show how controversial the topic has become.

Others, notably Navi Radjou and Jaideep Prabhu, have coined the term "frugal innovation," which entails cost reduction, concentration on core functionalities, and improved performance, taking inspiration from the Hindi concept of Jugaad *(eg Radjou et al 2012). These approaches share an awareness of the negative environmental consequences of existing production and economic models. According to the recently published* Handbook on Frugal Innovation *(Leliveld et al 2023), specific reference is also made to the economic downturn in rich countries, rising public expenditure for grand challenges, lack of access to public goods and services in low-income countries, and growing interest in innovation under resource constraints. In mountain regions, one example is renewed attention by state and nonstate actors, as well as scholars, to the innovative potential of autochthonous agricultural practices.*

Social innovation takes on particular significance when viewed through the lens of frugal innovation for sustainable mountain development. Social innovation implies an explicit consideration of the contribution of innovation to the wellbeing of people and the planet; the role of, and approaches to (transformative) learning and capacity building; the conditions ("tipping points") that facilitate transformation through innovation; and the proximate and wider institutional environment that enables social innovation. In other words, analysis of innovation should consider how specific forms of innovation in mountain regions can support sustainable development, and how sustainable development can facilitate directed, distributed, fair, and diverse, yet specific innovation needs in mountain regions.

This focus issue brings together a set of five contributions that reflect the diversified nature, processes, and impacts of innovation in mountain areas. Three contributions in the MountainResearch section present insights into different dimensions of innovation in mountainous regions in China and Europe. Zhou and He conceptualize innovation in mountain regions as a multidimensional and context-specific process essential for sustainable development. The authors distinguish between technological, social, and institutional innovations, highlighting how adaptive practices emerge from local resource constraints and community needs. Drawing on a detailed case study from Southwest China, they analyze how local communities responded to three decades of fluctuating walnut market booms and collapses. The article emphasizes participatory governance, coproduction of knowledge, and transdisciplinary collaboration as innovative mechanisms that transform mountain challenges—such as depopulation and climate vulnerability—into opportunities for experimentation. Innovation is analyzed both as an outcome and a process, often rooted in traditional ecological knowledge and social learning. Ultimately, the authors argue that mountain areas can act as "innovation laboratories" for broader sustainability transitions, where local experimentation produces scalable insights into resilience, adaptation, and equitable development.

Schmitt and colleagues empirically analyze innovation in 455 European mountain product value chains, identifying twelve attributes ranging from marketing and collaborative governance to ecological practices and social inclusion. Innovation is defined as both technological and social, encompassing adaptive, context-responsive changes across production, processing, and marketing. Using latent class analysis, the study maps how innovation attributes co-occur and cluster territorially, showing that successful mountain product value chains combine ecological, social, and economic dimensions. Rather than relying solely on high-tech solutions, the authors find, innovation emerges from place-based collaboration, traditional knowledge, and resource stewardship. The authors frame these innovations as drivers of inclusive, sustainable transitions in mountain economies, arguing for policies that recognize and support bottom-up, socially embedded innovation rather than imposing generic, productivity-oriented models.

Tassone and Musolino explore innovation as a transformative process toward a circular economy in Valle d'Aosta, Italy. Using a Policy Delphi approach with local stakeholders, they identify the circular economy as both an economic and social innovation requiring cultural change and collective awareness. Innovation here involves rethinking production, consumption, and governance systems through reuse, recycling, and community participation. The study reveals that while natural assets and community cohesion favor such transition, barriers include limited skills, weak political commitment, and outdated business models. Innovative strategies—such as training, participatory governance, and reward systems—are viewed as necessary to embed circularity within regional planning. The circular economy thus represents a form of systemic, place-based innovation aligning environmental stewardship, local identity, and sustainable development in high-mountain contexts.

The contribution in the MountainAgenda section offers the kind of insights called for by the mountains-as-battery trope cited above, though with a welcome slight twist. In "Alpine Spatial Planning, Energy Transition, and Open Spaces: An Agenda for Future Development and Governance," Marco Pütz and colleagues examine how spatial planning can reconcile Europe's accelerated renewable energy expansion with the preservation of open Alpine landscapes. Framed by the post-2022 energy crisis and the European Union's Green Deal, the article analyses ongoing transitions in Austria, Germany, and Switzerland involving wind, solar, and microhydropower. The authors highlight the Alps' dual role as an energy resource and an ecologically sensitive region, where intensified infrastructure threatens biodiversity and landscape quality. This contribution implies that innovation lies less in technology than in governance and planning approaches: it proposes an agenda integrating spatial, energy, and environmental objectives through cross-sectoral coordination, multifunctional land use, and participatory governance—thus complexifying the mountains-as-battery trope. By identifying 27 research questions, the article advances a forward-looking framework for innovative, integrative spatial planning that enables energy transition while safeguarding the ecological and cultural integrity of Alpine open spaces.

Finally, in a contribution to the MountainMedia section, Ignacio Palomo reviews The Canadian Mountain Assessment: Walking Together to Enhance Understanding of Mountains in Canada *by Graham McDowell, Madison Stevens, Shawn Marshall, and colleagues (University of Calgary Press, 2023). Palomo highlights innovation as a defining feature of the work's methodology, governance, and knowledge integration. The assessment is portrayed as an outstanding effort to coproduce knowledge between Indigenous and non-Indigenous contributors through a "Stewardship Circle" that guided both process and content, facilitating the fusion of scientific research with Indigenous oral knowledge gathered in "Learning Circles" and made accessible through embedded audiovisual materials. Palomo notes that this methodological novelty advances beyond previous international assessments by institutions like IPBES or the IPCC, which rarely achieve such meaningful integration of diverse epistemologies. Further innovation appears in the assessment's guiding principles—service, inclusivity, humility, responsibility, and action—which shape its open, reflexive, and action-oriented approach. Ultimately, Palomo sees* The Canadian Mountain Assessment *as the beginning of a continuing, collaborative, and innovative process to reimagine how mountain knowledge is produced and shared.*

*The hope expressed in this book review draws attention to a way forward in mountain research and development—an example of adoption of frugal innovation rather than a perpetuation of the mountain development narratives that have been leading to the anthropocentric demise of mountains. For such a research and development attitude to establish itself, however, resistance to the current cringing back into old narratives, attitudes, and habits will be needed. This will require novel perspectives, a humble understanding of science and development (**Jasanoff 2021**), and corresponding structures to support science and development.*

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