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Systemic thinking in mountain research impacts☆

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ABSTRACT

Tourism research often struggles to demonstrate its tangible influence on governance. This commentary presents a case in Valais, Switzerland, where sustained collaboration between academic institutions, public authorities, and industry translated scientific insights into tourism policy and practice. Several studies conducted in the region, including research on summer glacier skiing, contributed to climate adaptation, risk management, and destination resilience. Academic teams acted as trusted intermediaries by connecting research and decision-making through workshops, media engagement, and advisory roles. This long-term cooperative model supported knowledge transfer, informed cantonal climate strategies, guided tourism diversification, and stimulated public debate, illustrating how research can foster innovative governance and resilience in mountain regions.

1. Introduction: Academic research shaping tourism strategies and tourism policy

Research often contributes more clearly to conceptual frameworks, measurement tools, and best-practice guidelines than to concrete policy change (Thomas & Ormerod, 2017). Numerous studies also highlight that tourism practitioners make limited use of academic insights in strategic decision-making, largely due to weak knowledge-transfer mechanisms and insufficient collaboration between researchers and industry (Jones & Walmsley, 2022; Phillips et al., 2020; Ritchie & Ritchie, 2002). The industry's short-term profit motivations and organizational factors create barriers to implementing innovations rooted in research resulting in limited adoption of academic insights in daily operations (Kovács & Szabó, 2024; Phillips et al., 2020). Against the backdrop of limited evidence on the impact of research, this paper examines how academic research can generate impact on industry practices, policy development, and societal dynamics within tourism systems. Drawing on the study *Systems thinking to adapt tourism to climate change: Application to summer glacier skiing in Switzerland* (Gerber et al., 2025), it provides an illustration of how system thinking research has informed strategies and policy within the tourism industry in the Canton of Valais, in south-western Switzerland, and it highlights the active role of the cantonal administration in convening tourism stakeholders and academic institutions.

2. Conceptual and institutional context for tourism climate adaptation in Valais

The aforementioned gap between academic research and impacts in tourism-related contexts motivates our interest in assessing the influence of our research (Gerber et al., 2025) on tourism stakeholders in the studied destinations of Zermatt and Saas-Fee in the Canton of Valais, and on local and regional policy development. Unlike linear thinking, systems thinking focuses on studying the structure and interrelations of a system's different elements to understand observed patterns (Wright & Meadows, 2012). In tourism adaptation research, the industry is considered a complex, interconnected system (Loehr, 2020). Using a systems thinking approach, the authors (Gerber et al., 2025) highlighted the multiple pressures faced by destinations offering this activity and the sustained efforts needed to adapt to rapidly evolving cryospheric dynamics. The decline of Summer Glacier Skiing (SGS) is tied to climatic and socio-economic vulnerabilities and carries significant implications for cable car companies, hospitality providers, and the broader mountain tourism sector. The systems thinking approach used in this research

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revealed key feedback loops and leverage points, particularly those linked to uncertainties surrounding the long-term viability of the activity (Gerber et al., 2025).

Tourism is a cornerstone of the Swiss Alpine economy: in the Canton of Valais, the sector generated nearly 11% of the Canton's gross value added and about 20% of its jobs in 2014 (Grèzes et al., 2016). Within this context, the ski industry plays a central role in generating significant direct and indirect income and supporting a wide range of stakeholders (Gilaberte-Búrdalo et al., 2014). Despite growing climate pressures, adaptation strategies in ski destinations have largely focused on technical measures, such as optimizing grooming operations and expanding artificial snowmaking capacity (Steiger & Scott, 2020). Adaptation strategies in mountain tourism are often considered in isolation, from the perspective of one stakeholder, and fail to take into account the broader climatic, environmental, social and economic systems in which they operate. Tourism stakeholders also frequently perceive climate change as a distant phenomenon, both temporally and geographically (Vlès, 2021). This distance, combined with persistent communication gaps between scientists, practitioners, policymakers, and local communities, contributes to limited uptake of scientific findings.

In the Canton of Valais, several scientific institutions play an active role at the interface between research and public policy, notably the University of Applied Sciences and Arts of Western Switzerland (HES-SO Valais-Wallis) and the University of Lausanne (UNIL), with support from the cantonal *Service des Hautes Écoles* (SHE) which is in charge of coordinating research activities in the Canton of Valais. As a major academic institution in Valais, HES-SO Valais-Wallis combines tertiary education aligned with labor market needs with contributions to the region's economic, social, environmental, and cultural development. It plays a central role in applied research and innovation, working closely with public authorities and industry partners. This external orientation is reflected in the HES-SO Valais-Wallis PTR RISK-S project (Anzévui, 2025), which unites regional institutions to support authorities, businesses, and communities through applied research in prevention, decision support, training, and resilience. UNIL also maintains a strong presence in Valais, notably through its Chair of Tourism Studies, the Institute of Geography and Sustainability (IGD), and its research dedicated to mountain regions, with the Interdisciplinary Centre for Mountain Research (CIRM). CIRM advances knowledge on mountain sustainability and challenges through inter- and transdisciplinary approaches, while emphasizing public outreach and awareness-raising.

Within a broader network that also includes institutions such as the Federal Polytechnic School of Lausanne (EPFL) and the Regional Centre for Alpine Population Studies (CREPA), UNIL and HES-SO Valais-Wallis frequently collaborate in the organization of events and seminars, as well as in joint research projects. Their collaboration on the vulnerability of SGS destinations in Valais emerged in response to a call for inter-institutional projects issued by SHE. This project not only resulted in the publication of the article mentioned above, but also created a structured opportunity for collaboration between research institutions, policymakers, and local stakeholders in the destinations studied, thereby strengthening the pathways through which scientific knowledge informs decision-making and practice.

3. Theoretical perspectives on scientific research impact

The relationship between scientific research and its impact beyond academia has become a central concern in tourism studies (Jones & Walmsley, 2022; Phillips et al., 2020). At a foundational level, research impact can be distinguished between academic impact and external or societal impact (Jones & Walmsley, 2022). Academic impact refers to contributions to scientific debates, theories, and methodologies, typically measured through publications, citations, and scholarly recognition. External impact, by contrast, encompasses effects on policy, industry practices, communities, the environment, and quality of life. It is possible to distinguish between Mode 1 theoretical, discipline-based knowledge validated through peer review, and Mode 2 practical, context-specific knowledge validated by its usefulness (Gibbons et al., 1995). Traditional Mode 1 knowledge, characterized by discipline-based, theory-driven research validated through peer review, remains essential for scientific rigor. However, tourism research increasingly operates within Mode 2 knowledge production, where knowledge is co-produced with stakeholders, problem-oriented, context-specific, and validated through practical relevance (Tribe & Paddison, 2024). Within this broader understanding, the following categories of impact are particularly relevant with reference to our research project: industry impact, policy impact, and societal impact.

Research impact aimed at the industry involves not only the creation of new products or services but also includes operational changes, management systems, corporate social responsibility initiatives, and consumer education (Tribe & Paddison, 2024). However, a persistent divide between researchers and practitioners, driven by tensions between long-term sustainability and short-term business models, limits impact (Jones & Walmsley, 2022).

Impacts on policy rarely follow a simple linear transfer of knowledge; they take multiple forms, including conceptual impact and object formation. Conceptual impact involves “consciousness raising” or shifting the attitudes, knowledge, and understandings of policymakers. Object formation acts by constructing “objects” that enter the policy arena and force actors to reassess their positions (Buijtendijk & Eijgelaar, 2022). In fields such as climate change and tourism adaptation, discourse-oriented perspectives offer further insight (Jones & Walmsley, 2022), highlighting that research impact extends beyond direct policy uptake to include the gradual formation of shared problem definitions, narratives, and “objects” of governance.

Impacts on society assessment is fundamentally understood as the evaluation tool that identifies the social consequences of planned interventions produced after the development of research (Viana-Lora & Nel-lo-Andreu, 2023). Bottom-up approaches are widely recognized as effective in fostering such impact (Tribe & Paddison, 2024). Measuring societal impact is challenging and typically assessed before (ex-ante), during (in-itinare), and after (ex-post) research through anticipated benefits, productive interactions, and long-term social change (Viana-Lora & Nel-lo-Andreu, 2023).

4. From research insight to real-world impacts

Building on the theoretical foundations of industry, policy, and societal impacts outlined above, this section examines how these forms of impact materialize in the Canton of Valais through observable pathways. While these categories are closely interrelated in practice, distinguishing between them provides analytical clarity and helps to better understand the mechanisms through which research translates into real-world outcomes. Taken together, the following examples show a stepwise pathway from research production to stakeholder engagement, public debate, and institutional collaboration.

Research is embedded across the spheres outlined above through interdependent relationships that form a dynamic system (Fig. 1). While the following schematic representation may suggest a linear or hierarchical ordering, it is intended to emphasize the absence of such hierarchy, instead highlighting mutual influences and ongoing feedback across all elements.

4.1. Research impacts on industry

The study on SGS (Gerber et al., 2025) has generated several direct and indirect impacts on local stakeholders, particularly through applied research initiatives and participatory processes conducted by HES-SO Valais-Wallis and UNIL. Workshops designed and facilitated by researchers encouraged stakeholders to move toward a more systemic understanding of vulnerability in glacier-based destinations. Although participants were already aware of certain individual risks, the use of a

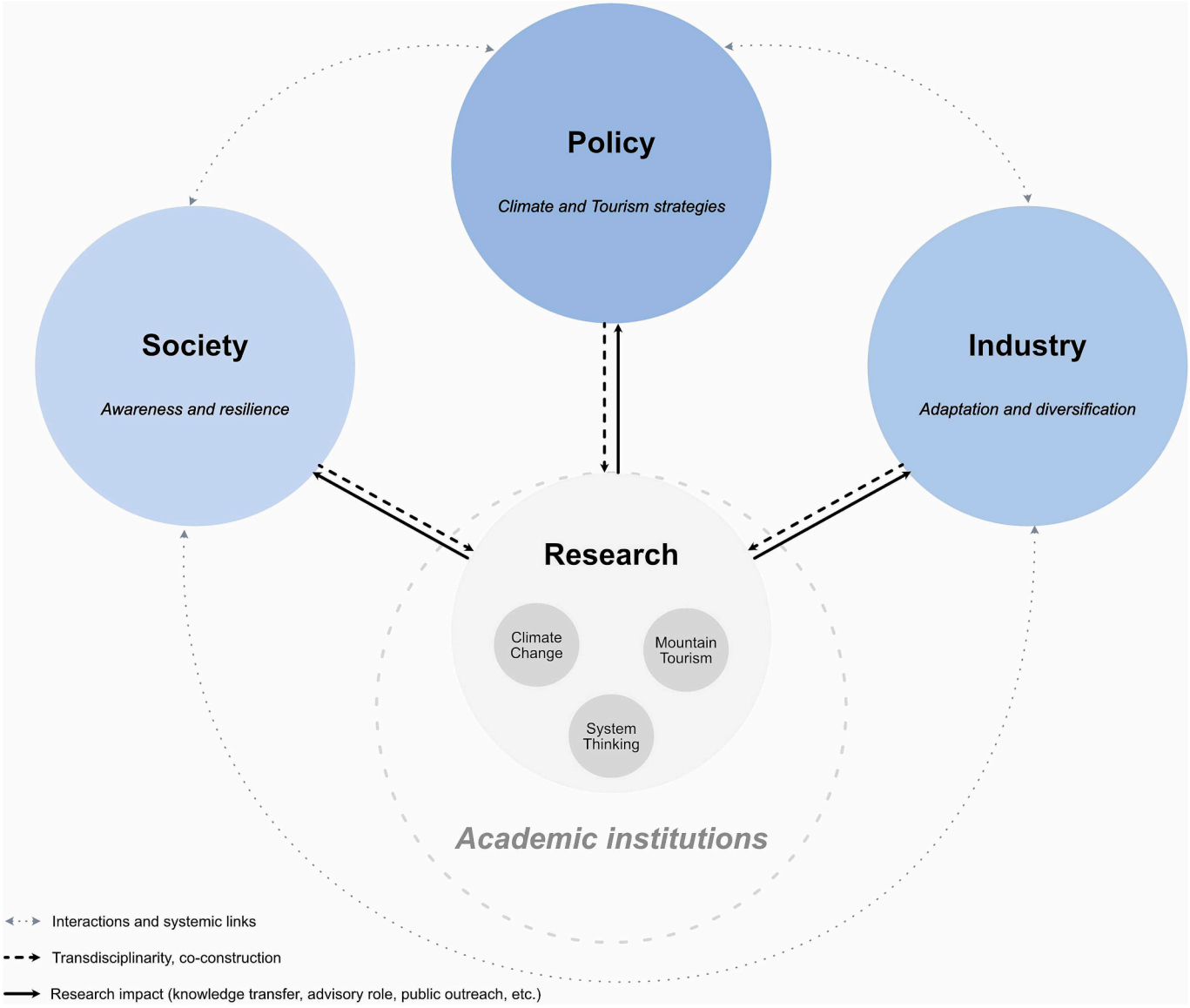

Fig. 1. Interactions between the research, industry, policy, and societal spheres.

causal loop diagram (CLD) enabled a holistic visualization of how environmental, operational, economic, and social dynamics interact, thereby expanding their analytical perspective.

While scientific climate projections consistently indicate that the practice will become unfeasible in the long term, it continues to be maintained as a revenue-generating activity. The prevailing business logic thus frames SGS as an industrial resource to be utilized for as long as it remains economically viable. In Saas-Fee, where SGS still generates substantial summer value, stakeholders particularly emphasized the relevance of research identifying systemic vulnerabilities, which reinforced the perceived need for flexible scheduling, operational redundancy, and long-term infrastructure investments. At the same time, participants acknowledged increasing challenges faced by athletes, including booking uncertainty, limited training terrain, and growing competition for glacier space. These developments highlight the need for stronger coordination among local service providers and targeted investments to maintain training quality as glacier retreat progressively reduces available snow areas.

Industry related adaptations reflecting these changing conditions can be observed. In Zermatt, for example, the cable car company has begun outsourcing operational risks. Until 2024, the company was responsible for both passenger transport operations and slope preparation (Gasser, 2025). In 2025, responsibility for slope preparation was transferred to the Swiss Ski Association, thereby redistributing part of the operational risk structure (Gasser, 2025).

Although a direct causal relationship between the research activities and the developments observed in Zermatt cannot be conclusively established, the example nonetheless demonstrates that operational changes are taking place.

4.2. *Research impacts on policy*

The public controversy surrounding the Matterhorn Cervino Speed Opening in autumn 2023 illustrates the growing socio-political sensitivity of glacier interventions and suggests that similar events may not be viable in the near future. Cantonal authorities have responded by reinforcing regulations to ensure strict adherence to approved glacier-skiing boundaries. Nonetheless, current adaptation approaches remain largely reactive, addressing glacier retreat after impacts emerge rather than pursuing proactive or transformative strategies. Strengthening sustained interactions between scientific institutions and public authorities will be essential to support more forward-looking adaptation

strategies capable of guiding glacier destinations through the structural changes imposed by ongoing climate change.

In the Canton of Valais, such collaboration is reflected in sustained partnerships with the SHE and the *Service de la Culture* (SC), notably through funding schemes such as the SC–UNIL grant supporting human and social sciences research in the Valais Alps. Also, building on collaborations from the *BlueMount* science-policy project (Cristofari et al., 2025), UNIL co-developed a call for transdisciplinary projects with the cantonal services of Vaud and Valais. The call, themed "*Adapting to Global Changes and Living Well in the Mountains*", invited projects that combine critical reflection and practical solutions for how cantonal departments can use scientific research to address adaptation to global changes. More importantly, as noted above, the collaboration between UNIL and HES-SO Valais-Wallis originated from a call for inter-institutional projects issued by SHE. Although recent developments in cantonal tourism policy – particularly the shift toward four-season tourism and the diversification of the tourism offer (*Le Valais veut développer son tourisme 4 saisons en 10 mesures*, 2025) – cannot be directly attributed to the study on SGS, the project nonetheless strengthened connections between academic research and political institutions. In this respect, it reinforced a research-policy network with the potential to inform future decision-making processes. It also illustrates the growing interest of public authorities in engaging with research on tourism issues.

The Canton of Valais has pursued a strategic policy aimed at attracting and developing tertiary education institutions within its territory. Consequently, close collaboration with Swiss universities, federal institutes of technology, and universities of applied sciences plays a central role in shaping both research agendas and policy outcomes.

4.3. Research impacts on society

At present, direct external impacts of the study on SGS are difficult to identify. It has primarily influenced tourism industry and stakeholders, highlighting how climate change and glacier retreat differently impact their activities and how these activities are interconnected, thereby fostering potential collaborations. By contrast, the societal impact of research tends to be more diffuse and to unfold over longer timeframes. This, however, does not imply an absence of research impact.

The societal impact of research in Valais is strongly shaped by the work of academic institutions such as UNIL, HES-SO Valais-Wallis, EPFL and the mountain-focused research centers, such as CREPA and the CIRM. In research, co-productive and transdisciplinary approaches are increasingly common. For example, the CIRM-led "*Val d'Hérens 1950/2050*" project is a participatory science initiative (Reynard et al., 2023) that engages local communities and governance stakeholders in co-constructing research questions, identifying local challenges, and exploring opportunities for "living well" in mountain regions. These activities reflect a bottom-up approach, bringing together local stakeholders, authorities, researchers and inhabitants in a tourism-reliant region. Beyond these research activities, this impact is further expressed through public awareness initiatives, and collaborations with regional associations and cultural organizations that directly engage local communities.

Education constitutes another key pathway through which these institutions generate societal impact. UNIL, EPFL, and HES-SO Valais-Wallis offer programs such as a B.A. and M.A. in Tourism, and a Certificate of Advanced Studies (CAS) in Tourism and Sustainability. These programs aim to deepen understanding of the impacts of climate change on tourism and to equip future professionals with analytical and operational tools to respond proactively. Furthermore, case studies on SGS in Zermatt and Saas-Fee, together with the systems thinking approach, are now integrated into the CAS, ensuring that research findings are directly embedded in professional training.

5. Conclusion

The Valais case shows that significant change comes from institutional collaboration rather than individual academic efforts. UNIL, HES-SO Valais-Wallis, and partner research organizations created a trusted interface between science, policy, and practice by working hand in hand. This sustained collaboration allowed the cantonal authorities to incorporate research findings into climate strategies and tourism adaptation plans, and prompted industry stakeholders to adjust their operations and expand their offerings. Beyond providing technical recommendations, these partnerships have fostered dialogue, public awareness, and a sense of shared responsibility for mountain sustainability. This experience shows that when academic institutions work together and engage deeply with governance structures, they can generate transformative changes in tourism policy and strengthen the resilience of destinations.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the authors used ChatGPT (free version, OpenAI, 2025) to assist with improving the clarity and accuracy of the English language. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

CRediT authorship contribution statement

Jeanne Fournier: Writing – original draft, Methodology, Conceptualization. **Ephraim Gerber:** Writing – original draft, Methodology, Conceptualization. **Emmanuel Fragnière:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Emmanuel Salim:** Validation. **Leïla Kebir:** Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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