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A South–North research agenda for *cryotourism* in a warming world

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Cryotourism is a distinct form of tourism which is based on ice and snow cover and is thus highly determined by climatic conditions. While a considerable body of literature addresses the tourism-climate change nexus in (sub-)Arctic and European Alpine regions, little is known about the situation in South American high mountain and sub-Antarctic areas. Against this background, this perspective article presents a research agenda for cryotourism-climate change nexus from a South–North perspective. The initial step toward this objective was an 18-days research visit in Chile and Argentina during January and February 2024. Drawing upon our field notes, current literature and the latest developments in ice and snow-based tourism, we propose three key dimensions for a research agenda, namely: (a) tourism mobilities and southward spatial substitution, (b) socio-ecological implications of *cryotourism* for local communities, and (c) governance challenges for tourism stakeholders and policymakers. We contend that interdisciplinary and transdisciplinary approaches to tourism and climate change research are key aspects to account for the global nature of tourism mobility flows, and the interlinks between local and global processes and impacts of climatic environmental transformations.

KEYWORDS

ice, snow, glaciers, nature-based tourism, cryotourism, climate change, peripheries

1 Introduction

In addition to conventional sun, sea, and sand destinations, polar, subpolar, and mountain regions are becoming increasingly popular among holidaymakers to experience the Earth's cryosphere (Demiroglu et al., 2020; Navarro-Drazich et al., 2023; Bohn, 2024; Makanse and Huijbens, 2024). We define cryotourism as a form of tourism that is performed in ice- and snow-covered landscapes (e.g., mountains, glaciers, fjords and tundra) including human-made and nature-based attractions (Demiroglu, 2026, forthcoming; Yang et al., 2023). Skiing is by far the most prominent tourism activity in snow-covered and glacial areas. For instance, in northern Europe, cross-country and downhill skiing have a long tradition in outdoor recreation and domestic winter tourism (Demiroglu et al., 2020). Similarly, both downhill and randonnée skiing in the southern Andes attract a growing number of international and domestic tourists (Garretón, 2024). Moreover, snow-covered areas suitable for ski tourism and

professional training are important attractions for those who alternate between boreal and austral winters (Salim et al., 2024; Gerber et al., 2025).

Export-oriented tourism offerings based on ice and snow in (sub-) Arctic Europe, i.e., the northern parts of “Northern Europe” according to the climate reference regions of the IPCC (Iturbide et al., 2020), focus predominantly on soft winter activities suitable for mass markets, such as dog-sledding, reindeer safaris and aurora borealis viewing (Rantala et al., 2018). Alongside these nature-based tourism services, human-made attractions utilizing cryosphere elements have co-evolved. Well-known examples include the Icehotel in Jukkasjärvi, northern Sweden, which has been replicated in similar form around the world, and the numerous glass igloo resorts in northern Finland, offering travelers the opportunity to experience snow-covered landscapes and the northern lights from the comfort of an indoor environment (Bohn, 2024). Sought-after non-skiing products in southern mountain destinations include backpacking, hiking, horse trekking, and navigation in glacial terrains (Blair et al., 2019; Bachmann-Vargas et al., 2024).

Last chance tourism motivations, referring to the desire to see glaciers, snow-covered mountains, and charismatic fauna, such as penguins and polar bears, before they are gone for good (Lemelin et al., 2010), and demand for outdoor experiences in dramatic landscapes (Makanse and Huijbens, 2024), have transformed cryosphere landscapes into major international and domestic tourist attractions. As such, cryotourism has become an important source of revenue not only for large industry players, such as lift operators, airlines, hotel chains and tour operators but also for micro-sized tourism businesses and the host regions. In many Northern and Southern peripheral areas, tourism based on the commodification of ice and snow represents therefore an important industry path within wider regional development efforts (Rasmussen, 2019; Bohn, 2024).

Yet, cryotourism is directly dependent on climate and weather conditions, making it highly vulnerable to the effects of climate change (Furunes and Mykletun, 2012; Demiroglu et al., 2020).

Whereas a considerable body of literature addresses the interrelationships between tourism, culture, economic development and climate change in (sub-)Arctic locations (e.g., Welling et al., 2015; Demiroglu et al., 2020; Salim et al., 2021), little is known about the tourism-climate change nexus in South American high mountain and sub-Antarctic areas, i.e., the southern and southwestern South America (SSA and SWS) reference regions of the IPCC (Iturbide et al., 2020) extending through the Andes and the Patagonian ice fields and fjords (Navarro-Drazich et al., 2023; Demiroglu et al., 2024; Steiger et al., 2024). Research gaps include an understanding of the southward substitution of ski tourism and small-scale glacier tourism (e.g., Steiger et al., 2019; Salim et al., 2024; Gerber et al., 2025), as well as the socioeconomic importance of ice- and snow-based tourism for the southernmost regions (Kaenzig et al., 2016). In both Southern and Northern peripheries, several unanswered questions remain regarding the significance of this type of tourism for local communities and the specific challenges encountered by the tourism sector and policymakers.

The aim of this paper is thus to establish a research agenda on cryotourism-climate change nexus, with an explicit South–North perspective, in order to better understand the global nature of climate change effects and tourism mobility flows in relation to locally specific impacts and adaptation strategies. By doing so, this agenda works

toward building inter-hemispherical research and practitioner cooperation, encouraging mutual learning, capacity building and solidarity (e.g., Ostrom, 1990).

2 Method

To develop our research agenda on cryotourism-climate change nexus, we conducted an 18-days research visit in Chile and Argentina during January and February 2024.

While in Chile and Argentina, we held three research meetings and five case study visits. The research meetings in Santiago, Coyhaique and Ushuaia were structured based on individual presentations followed by an open discussion session. Each meeting addressed different aspects of cryotourism, which were determined by the geographic location and the expertise of the local researchers, whom are co-authors in this research note. Three main questions guided our discussions, namely: (a) what is the ecological/economic significance of glacier and snow-based tourism development? (b) what are the implications of cryotourism for local communities? and (c) what are the main challenges faced by tourism stakeholders and policymakers?

Our research meetings were attended by colleagues, practitioners and students related to each of the host institutions where the meetings were held, covering a wide range of expertise such as high mountain permafrost, glaciology, protected areas, tourism development, environmental policy and ski business. In total, 19 participants attended our meetings. Meetings were held in English and Spanish and were video recorded using MS Teams.

In addition, the case study visits allowed us to engage in participant and non-participant observation of cryotourism development. The case studies were purposefully chosen to provide us with a diverse sample of cryotourism destinations in the southern parts of South America. The first visit was focused on high mountains and ski resorts (Valle Nevado and La Parva, Chile). The second visit was aimed at glacier tourism, hiking activities, and small-scale tour operators (Exploradores glacier, Chile). The third visit gave us an overview of nautical-based glacier tourism operated by small-scale tour operators (San Rafael lagoon, Chile). The fourth visit exposed us to larger numbers of tourists and more accessible forms of glacier tourism (Perito Moreno glacier, Argentina). The final visit led us to hike to the Martial glacier, in Ushuaia, to understand how glacier and ski recreation and tourism have changed in the southernmost city of Argentina.

We compiled and shared our field notes, and other related activities in our ArcGIS Story Map titled “Cryotourism in a warming world”.¹ Drawing on our preliminary questions and employing a process of collective hermeneutics (e.g., Molitor, 2001), we identified three key themes that advance the understanding of the cryotourism-climate change nexus, namely, tourism mobilities and southward spatial substitution; socio-ecological implications of cryotourism for local communities; and governance challenges for tourism stakeholders and policymakers.

¹ <http://tiny.cc/cryo-tourism>

We are aware of the limited extent and the qualitative nature of our discussions, along with the small number of case study visits. Additionally, cryotourism research is highly determined by winter or summer seasons, weather conditions, accessibility and budget. On the positive side, we managed to get a glimpse of diverse cryospheric environments facing similar challenges around tourism development and climate change. Further, our Story Map has contributed with place-based information to the geospatial catalog of Chilean Patagonia.²

3 Insights from the field: key aspects for a research agenda on cryotourism

Building upon our combined expertise (e.g., climate change and tourism, environmental policy, glaciology, governance, nature conservation and political economy), extensive fieldwork experience (e.g., in northern Europe, southern South America and in the high Andes of southwestern South America), field notes, current literature and the latest developments in ice- and snow-based tourism specifically in South America, we propose three key dimensions for a research agenda on cryotourism-climate change nexus.

3.1 Tourism mobilities and southward spatial substitution

Tourism, and especially nature-based tourism associated with ice and snow relies on the capability of tourists to move to and through cryotourism destinations. Therefore, different elements of tourism mobilities are of particular importance for a research agenda on cryotourism. Building on Cresswell (2010), speed, rhythms, routes, and frictions are relevant elements of tourism mobility to consider in both practices and governance associated with cryotourism. In Chilean southern Patagonia, Barrena Ruiz et al. (2019) analyze how such elements of nature-based tourism mobility challenge traditional forms of nature conservation governance based on fixed spatial boundaries. In line with this previous research and drawing upon our insights from the field, it is possible to argue that the current climate-driven changes in ice and snow-covered areas are triggering new forms and patterns of mobility among tourists and, therefore, creating new multifunctional tourist spaces. For instance, climate related impacts are producing important changes in glacier structure driving the search for new ice-based attractions in Patagonia. As we learned in the field, these climate pressures have particularly affected tourism activities in the Exploradores glacier, Chilean northern Patagonia, where hiking routes had to be adjusted according to the increasing thawing of the glacier (field notes).

On the other hand, cryotourism research needs to pay further attention to southward spatial substitution. Steiger et al. (2019) point out the lack of research of ski markets in South America, though the preferences of North American and European professional ski and snowboard teams to travel south during the austral winters is quite common. Demiroglu et al. (2018) also indicate a similar tendency

from Norwegian skiers for South American winters. However, in southernmost ski resorts, such as in Punta Arenas (51°S), frequent closures have been recorded mainly due to a precipitation shift from snow to rain along with a significant reduction in the snow cover in the 45-year period 1972–2016 (Aguirre et al., 2018).

Currently, new foreign investments are positioning Valle Nevado-La Parva (Chile) as the largest ski resort in the Southern Hemisphere, offering downhill slopes approved by the International Ski and Snowboard Federation (FIS), and access to 30 lifts accompanied by a range of outdoor activities. According to one of the managing partners, it is expected to build new lifts, add snowmaking and to develop more trails (MCP, 2024). Likewise, another ski resort is planned to be developed in Argentina, targeting the global market (Vanat, 2024). Consequently, the number of winter tourists is expected to grow, thus potentially increasing the southward flows, bringing to the front the question about sustainable development of ski tourism in South America and the tourism carbon footprint (Navarro-Drazich et al., 2023).

We contend that further research on tourism mobilities and southward spatial substitution is highly needed to better inform practices and policies at the intersection of cryotourism and climate change.

3.2 Socio-ecological implications of cryotourism for local communities

Socio-ecological implications of ice- and snow-based tourism have gained attention in the light of the current climate crisis. Glacier retreat, glacial lake outburst floods (GLOFs), and a shortage of snow, along with the increasing demand for ice- and snow-based attractions are reshaping tourist destinations. For instance, Salim (2021) points out three adaptation strategies to the glacier loss in the Alps, namely: advancing geotourism, transforming last-chance tourism into ‘dark tourism,’ and developing virtual reality. Meanwhile, the increasing demand for Antarctic cruise tourism has led to new narratives of place-making (Varnajot et al., 2024), whereas gateway communities face the challenges of managing cruise ship-generated waste (field notes).

Local communities depending on cryotourism activities are highly vulnerable to the fluctuations of the ice and snow conditions, particularly in remote peripheral areas. While in the field, we learned that regional authorities had suspended tourism activities in one of the most iconic glaciers in northern Patagonia, Chile, sparking the local discontent and the debate about decision making in times of climate change (López Espinoza, 2023). One of the sections of the Exploradores glacier had collapsed. After approximately 100 days, tourism activities were allowed to resume yet leaving behind serious economic consequences for the local community and tour operators (field notes). The closure of the glacier for almost the entire high season sparked the debate on socio-ecological implications of glacier tourism for the local community and climate change adaptation. Previous GLOF events had already drawn attention to changes in the glacier structure (Colavitto et al., 2024). Up to our knowledge, this is the first case in Chile that illustrates the importance of a better understanding of cryotourism-climate change nexus and their implications for local communities. Further research on socio-ecological implications should look at tourism-climate change nexus to inform just adaptation, encompassing scientific and local knowledge alike. Interdisciplinary and transdisciplinary approaches are key to advancing a research agenda on cryotourism (Welling et al., 2015; Stewart et al., 2016). Furthermore,

² <https://geoportalcienciaaustral-ciep.hub.arcgis.com/>

creative research methods such as serious games can contribute to analyze different scenarios related to socio-ecological implications of cryotourism and climate change, thus increasing the engagement of non-academic actors (Pollio et al., 2021).

3.3 Governance challenges for tourism stakeholders and policymakers

In (sub-)Arctic Europe as well as in southernmost South America, tourism based on the commodification of glaciers, ice, and snow is of growing importance for regional economic development (FAO/UNWTO, 2023; Bohn, 2024). Yet, the aspiration of most destinations to boost inbound visitation combined with the rising number of globally mobile travelers consuming carbon-intensive services, is driving up greenhouse gas emissions, with little indication of rapid decarbonization. Sun et al. (2024) found that the carbon footprint of the travel and hospitality sector expanded between 2009 and 2019 at a rate of 3.5% per year, while that of the global economy grew annually by only 1.5%. The accelerating effects of climate change are unevenly distributed between different places (e.g., Carey and Moulton, 2023), posing both short- and long-term threats to ecosystems and local livelihoods based on cryotourism. Recent climate projections indicate that the speed at which climate change will alter cryotourism is highly localized. For instance, snowfall reduction and freezing level heights across the Chilean Andes vary significantly at different latitudes and altitudes (Vásquez et al., 2025). Hence, policymakers and stakeholders face significant challenges in balancing the continuation of cryotourism as an economic pathway while decoupling sectoral growth from emissions and implementing

local adaptation strategies. The prospects of cryotourism depend therefore not only on natural ice and snow conditions, but also on broader nature conservation policies, governance capacity for change and resilience management, and market innovations surrounding ice- and snow-based tourist attractions.

In the following table (Table 1), we present the main risks and opportunities of cryotourism in northern Europe and in southern and south-western South America that were identified during our research meetings. These issues provide key pointers for academic audiences as well as stakeholders and policymakers on the future of snow- and ice-based tourism.

4 Concluding remarks

In this perspective article we outlined the first steps of a research agenda for cryotourism-climate change nexus from a South–North perspective, with a special focus on South America. We advocate for comparative, interdisciplinary and transdisciplinary research to better inform the governance of the cryotourism-climate change nexus. We emphasize that tourism mobility patterns and southward spatial substitution, along with socio-ecological implications of cryotourism for local communities, as well as the challenges faced by tourism stakeholders and decision-makers are key dimensions for further research on cryotourism. Ice- and snow-based activities primarily take place in remote northern and southern regions, characterized by vulnerable socio-ecological systems that are disproportionately impacted by the effects of climate change. The future of cryotourism is therefore uncertain, and policy frameworks facilitating adaptation as

TABLE 1 Risks and opportunities of cryotourism.

Cryotourism aspect	Northern Europe		Southern and southwestern South America	
	Risks	Opportunities	Risks	Opportunities
Business	Shortened skiing season due to decreased snowfall and glacier retreat, increasing rain on snow events	Development of new adventure tourism activities due to changing landscapes	Shortened skiing season due to decreased snowfall and glacier retreat, increasing rain on snow events	Increased interest in alternative nature-based tourism activities such as mountain biking and hiking
	Increasing southward substitution of ski tourism	Lower carbon footprint	Increasing carbon emissions	Increasing number of tourists
	Reduction in ice climbing and glacier trekking opportunities	Investment in infrastructure to adapt to changing conditions	Loss of revenue for tourism firms offering glacier-related activities	Diversification of tourism offerings including cultural experiences and coastal and marine attractions
Policy	Increased pressure for regulations on carbon emissions	Incentives for businesses to adopt sustainable practices, investments in carbon-neutral transportation, target market innovations	Need for stricter conservation measures to protect fragile ecosystems	Potential for co-management strategies in multiple-use protected areas
	Implementation of stricter environmental regulations	Development of policies promoting conservation and sustainable tourism	Transboundary disputes over cryosphere resources	Development of joint tourism initiatives between neighboring countries
Society	Disruption of traditional livelihoods in cryosphere-dependent communities	Increased awareness and education on climate change impacts	Loss of heritage as glaciers disappear	Preservation and promotion of local knowledge and cultural practices
	Loss of heritage as glaciers recede and landscapes transform	Opportunities for cultural exchange and community resilience	Climate-induced migration from affected regions	Development of climate-resilient communities through sustainable tourism initiatives

well as mitigation are needed to sustain local livelihoods and ecosystems. Knowledge of how climate change unfolds locally, and in conjunction with other socioeconomic and environmental stressors, is needed to guide forward-looking decision-making and planning. At the same time, comparing research insights from both the South and North contributes to a more comprehensive understanding of our changing world, offering valuable perspectives on globalization and potential pathways to resilience.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

PB-V: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. OCD: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. SRP: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. DB: Conceptualization, Writing – original draft, Writing – review & editing. MV: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. TG: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. JB: Conceptualization, Writing – original draft, Writing – review & editing.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The handling editor ES declared a past co-authorship with the author OCD.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

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