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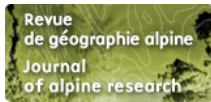
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Science as a Resource for Territorial and Tourism Development of Mountainous Areas of Chilean Patagonia

Fabien Bourlon, Yannick Vialette and Pascal Mao

- 1 Science and mountains are strongly related (Joutard 1986). Debarbieux (2001; 2006) even considers that mountains constitute an “outdoor laboratory” for science. Acquiring new knowledge favors the invention of new resources. The mountains, which are particularly impacted by contemporary climatic and societal changes, see mobilities evolve and new ones emerge (Bourdeau, 2006). Scientific tourism practices (Mao, Bourlon, 2016) allow us to grasp these dynamics. They highlight a network of actors who mobilize science as a resource involved in territorial development dynamics. Vialette *et al.* (2021) show that the scientific mediations implemented in mountain areas respond to various publics’ expectations and to an increased demand for more awareness of global issues.
- 2 This article seeks to show, more specifically, through the analysis of scientific tourism in Chilean Patagonia, the interrelation between a scientific resource, local development, and the attractiveness of a mountain territory. To comprehend these issues, the notion of resource and the ways in which science is perceived as a territorial asset are explained. A corpus of seven scientific tourism initiatives in a mountainous area is analyzed to show the different forms of activation of a scientific resource. A following discussion underlines the importance of actors as territorial stakeholders in the selection, the revelation, and the valorization of these resources and what they reveal about a specific geographical area.

From Resource to Territorial Resource

- 3 Nunes and Sousa (2019) show that territorial coherence and competitiveness require a better understanding of scientific resources. The latter have the potential to be “perfect resources” because they are unique, globally available, locally abundant, rooted in the territory, and mobilizable by actors (Nunes, Sousa, 2019). The resource is evolving by nature. It is a human representation nourished by knowledge produced on a person in each social context. It is technicity, understood as “the set of relationships that man, as a member of a group, maintains with materials” (Raffestin, 1980), that allows matter to become a resource. Thus, science maintains a double relationship with the resource. Not only is science central to the technique of inventing resources, but it can also become a resource in itself. Indeed, the scientific approach, through the employed methods and knowledge provided, actively participates in the invention of new resources.
- 4 A resource can be specifically exploited on a territory and gives rise to the notion of “territorial resource”, a notion that involves a dynamic dimension, a construct in and through action (Blot, Milian, 2004). They can be distinguished into two categories: generic resources, which are transferable because their construction or use is not linked to local constraints, and specific resources, which involve a higher and irrecoverable cost of transfer (Courlet, Pecqueur and Soulage, 1993). From this point of view, science is both a material and immaterial resource. Science can be mobilized (François, Hirczak, and Senil 2006) to meet different development objectives, especially in the context of localized cultural systems (Corneloup, Bourdeau, and Mao 2004). “All spaces ‘potentially’ have resources... provided that they are brought to light and used to best advantage” (Pecqueur, 2002). Specific resources allow for sustainable differentiation, as they partially escape market competition (Colletis, Pecqueur, 2018).
- 5 The resource is therefore always relative, its use value depending on its socialization and appropriation by actors within a territory. The challenge for territories lies in its capacity to transform the status of a resource to give it a collective value. For Peyrache-Gadeau and Pecqueur (2004), the “re-qualification” of specific resources involves “various processes by which a local society organizes itself to reconsider the collective value attributed to the resource”.
- 6 At the heart of this process is “territorial operator”, a key leading institution that favors the revelation and the valorization of a resource (Durand, Landel, 2020). It is crucial to consider both dimensions, global, dependent of a global context, and local, related to the local empowerment and construction by project leaders, in activating links between the resources and the territory. The operator is the bridge between the territory and the market and is likely to favor mechanisms of reciprocity between the processes of valorization and revelation. He is the window through which specificity is perceived (Hirczak, François and Senil, 2007). He highlights the contingency of specificity and reexamines the nature of a resource.

Enhancing Scientific Resources Through Tourism

- 7 Resource is a tool to increase territorial attractiveness, and tourism is witness to ways in which it is valued. Tourism plays a key role in revealing a resource due to its

external point of view about the attributes of the territory. A direct valorization of the resource exists through products and services offered in the destination. Tourism development has been grounded in science in Chilean Patagonia (Bourlon, 2020a; Bourlon *et al.*, 2021) and the study of available offerings highlights the strong ties between this territory and its scientific resources. Scientists use a geographical area as a resource to carry out their experiments. The knowledge they produce becomes a useful resource for the development of different forms of tourism, such as ecotourism (Laarman, Perdue, 1989; Wearing, Neil, 2000; West, 2008) or learning tourism (Slocum, Holden & Kline, 2015; Ilynia, Mieczowski, 1992). A synthesis proposed by Mao and Bourlon (2011, 2016) concludes that four forms exist depending on whether the scientific approach is central or secondary and whether the personal involvement of tourists is strong or passive. A recent study shows the diversity of mediation possibilities in the French Alps, using a wide range of scientific resources (Viallette, Mao and Bourlon, 2021). Although special interest tourism appears secondary in global flows of travelers in international statistics, scientific tourism can support and enhance development in remote areas with high biodiversity (Mittermeier *et al.*, 2003), little infrastructure, limited means of access and a weak organization of services (Bourlon, 2020b). The step-by-step process of identifying scientific resources and shaping it as a relevant local patrimony and its valorization have been described in the Aysén region (Mao, Bourlon, 2016; Bourlon *et al.*, 2021). This article pursues this work by studying the intentionality of stakeholders mobilizing science as a resource for tourism development.

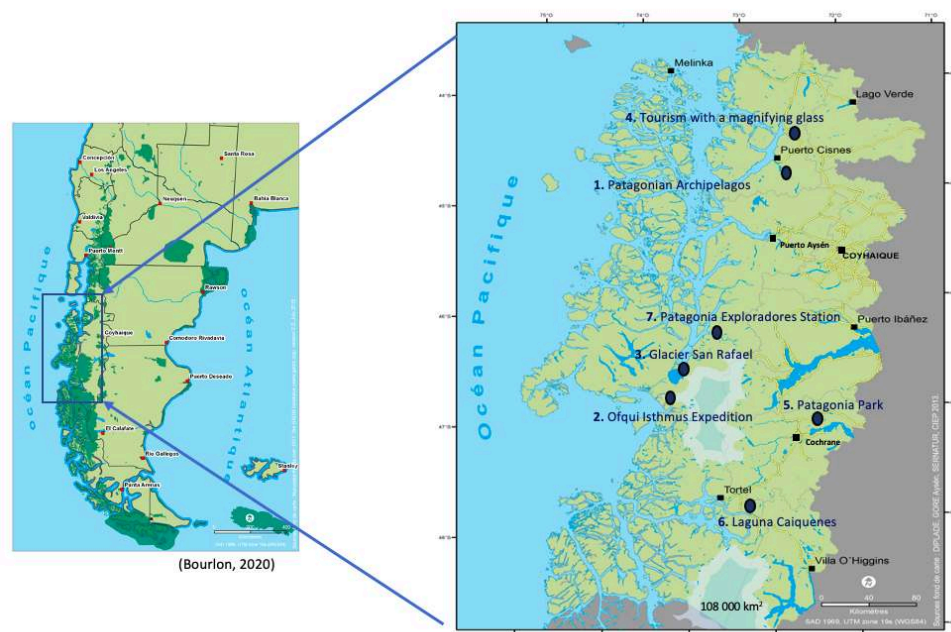
The region of Aysén, a Touristic, Scientific, and Mountainous Borderland

- 8 The mountainous region of Aysén in Chilean Patagonia has a lasting tradition of inventions related to scientific activity. Research has been carried out in this region since the first explorations when the territorial boundaries between Chile and Argentina were being defined. Its status as a frontier land constrained research (Gobierno Regional de Aysén, 2005), the austral road, the creation of infrastructure (public-private laboratories in agronomy, fishing and forestry) and settling of university laboratories (Los Lagos, Austral de Chile, and Concepción Universities, for example) enhanced studies in the 1990s. In 2005, the creation of the Centro de Investigación en Ecosistemas de la Patagonia (CIEP) increased synergies that favored new research. From then on, many scientific resources, on various issues have been revealed and revalued (Lozano, Inostroza and Salgado, 2010; Rivera-Polo, Rivera-Vargas and Alonso-Cano, 2018), highlighting the strong link between science and mountainous environment.
- 9 Aysén relies on research, and the resources derived from it, for its development. The following selected initiatives were chosen from over sixty identified in regional studies conducted between 2013 and 2018 (Mao, Bourlon, 2016; Bourlon, 2020a). This Andean region stretches from the Pacific Ocean coastal range in the west to the Argentine Republic in the east. It is one of the least populated regions in Chile, with a total of 103,158 inhabitants and an average population density of 0.95/km², reaching a minimum of 0.027/km² in the municipality of Tortel, in the extreme south part of the region. The capital Coyhaique has 49,667 inhabitants but villages where scientific

tourism activities take place are rural and sparsely populated: Puerto Cisnes (2,558 inhabitants), Puerto Tranquilo (458 inhabitants), Cochrane (2,789 inhabitants), and Tortel (436 inhabitants) (INE, 2019).

- 10 Tourism emerged in the 1990s as an alternative option for the socioeconomic development of the region of Aysén, mainly to provide complementary income to rural families (Muñoz, Torres-Salinas, 2010). It has grown steadily over the last two decades. The number of travelers increased from 193,000 visitors in 2000 to 566,000 in 2016 (SERNATUR, 2017). According to the 2017 Aysén Region Tourism Industry Analysis Report, annual tourism revenues in the region exceeded than some US\$54.6 million.
- 11 The scientific tourism initiatives studied are located within three main tourism areas, those officially recognized by the Chilean state: Aysén Patagonia-Queulat, Lago General Carrera—Chelénko and Los Glaciares (Subsecretaría de turismo de Chile, 2022). Tourist highlights are Queulat (38,150 visitors), Laguna San Rafael (6,114 visitors) and Patagonia (8,797 visitors) national parks and the Capillas de Marmol natural monument (35,000 estimated visitors) (CONAF, 2020). Most of tourism activities occur along the route of the Carretera Austral, a 1,240-kilometer scenic highway that crosses the region from north to south. Although some small private lodges offer high-end all-inclusive packages, the bulk of tourism activity focuses on rural lifestyles. Activities offered by micro-entrepreneurs combine fly-fishing, horseback riding, boating, kayaking, park visits and trekking. Towns closer to the southern route receive most travelers.

Figure 1. Location of seven scientific and tourist projects in the Aysén region, Chile.



- 12 Based on interviews with project leaders, a grid was applied to highlight the main objectives of involved stakeholders, the geographical location of the activity, the scientific fields addressed and ways of valuing the scientific resource. The classification of scientific issues follows that defined by the international scientific tourism network (INST, 2021) based on UNESCO's recommendations (UNESCO, 2014). The category of stakeholders and scientific mediations forms follows those identified in previous studies (Mao, Bourlon, 2016; Vialette, Mao and Bourlon, 2021).

The Activation of the Science Resource in Chilean Patagonia

- 13 The seven initiatives that were selected in the Aysén region rely on various scientific resources. All deal with the socio-economic and territorial development, strengthening research, education and tourism, as enhanced in the regional government policy (Gobierno Regional de Aysén, 2015). They are supported by regional development funds for entrepreneurs along with specific public helps to foster local development.
- 14 The Patagonia Archipelagos project¹ (study case n° 1) sought to enhance coastal mountain ecosystems for a “tourism development that respects local communities and the fragile environment” (Bourlon, 2020a). The public-private research center CIEP organized scientific exploration to emblematic locations between 2013 and 2016 and organized educational activities with tourism entrepreneurs from remote villages. Among the direct effects on territorial development of this project are the establishment of a baseline of existing knowledge of the territory (within a scientific tourism guide), the creation of recreational and commercial products and thematic interpretation supports. The sharing and interpretation of scientific knowledge, education of local actors about environmental issues and the establishment of a network of entrepreneurs strengthened territorial tourism.
- 15 The scientific expedition to the Ofqui Isthmus² (case n° 2) aimed to gather new knowledge on the ecosystem of the glacial areas of the Northern Patagonian Ice Field, its periglacial areas, and the Pacific coastal range. Organized in March 2014 by the CIEP research center and the Universities Austral de Chile, Pratt and Grenoble Alpes, this 15-day exploration made a geographic survey of relevant geological, biological and archaeological sites. The identification of fragile ecosystems and remarkable species revealed ecological issues at stake in a little-known part of the UNESCO Biosphere Reserve Laguna San Rafael and El Guayeneco. The researchers, supported by tourist operators, traveled through the area, and conducted two public sessions to share preliminary scientific results to local communities. A scientific exploration report identifies itineraries, fragile areas and gives recommendations about the opening of the area to ecotourism activities with scientific and educational content.

Illustration 1. The mountainous area as research site; a scientific station on the North Patagonian Icefield, Laguna San Rafael National Park 2010



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- 16 On the lower part of the San Rafael Glacier (Figure 1), some operators, such as Destino Patagonia³, offer their services to scientific expeditions. Permanent camps are installed on or near the Patagonian ice field, a vital need to access the area. These are used as a base camp for further explorations to more unknown geographical areas. Different research in glaciology and climate change are developed there by international teams. Camps are used to support adventures and sport expeditions to ascent nearby summits, with the help of specialized guides. Scientific expeditions, in the strict sense, generate new special interest tourism products. The creation of specialized and public interpretation materials contributes to new media coverage and communication about the area.
- 17 The program “Tourism with a Magnifying Glass” (Turismo con Lupa) carried out by the Universidad Austral of Chile⁴ (case n° 4) is interested in the plant microbiology of the cold deciduous forests, particularly the bryophytes, lichens, and fungi in Glacier Queulat National Park. The knowledge acquired by the researchers is shared with school children and tourist guides from nearby villages through workshops. Forest sites and itineraries are promoted and integrated into the training of students in natural science degrees. They are also accessible to a broader public during trekking activities led by local guides.

Illustration 2. The mountain area as a place for citizen science; volunteers helping collect biological data in Patagonia Park, 2007.



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- 18 The Patagonia Park Ecovolunteer Program⁵ (Case n° 5, Figure 2), in the Chacabuco River Valley and current Patagonia Park, in the municipality of Cochrane, has been organized by the conservation foundation (Fundación Tompkins) and a non-profit association (Corporación para el Desarrollo de Aysén CODESA) on several occasions since 2008. The census of species of the Patagonian steppe has provided data on the ecosystems that are on display today in an interpretation center in the heart of this mountain valley. This site allows visitors to have access to quality scientific mediation (Figure 3) highlighting the little-known biodiversity of these areas. Various educational trips organized by local or international universities are based on the results of this research.

Illustration 3. The mountain area as a support for scientific mediation, a researcher shares his knowledge with students, Patagonia Park, Aysén, in 2019.



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- 19 The regional association for the protection of local heritage, Aumen⁶, obtained a concession of 8000 hectares of state land in the rural municipality of Tortel, Laguna Caiquenes (case n° 6). Members study the area in association with the Regional Museum of Aysén. The scientific activity focus on the biodiversity of a lake and the temperate forest of the coastal range. Researchers share their knowledge through field visits and workshops for university students and children of nearby villages. The site has become a tourist stop on the southern route and the museum shares findings in the regional capital allowing schoolteachers, students, and entrepreneurs to use new knowledge in classes and activities.
- 20 The Patagonia-Bahia Exploradores scientific station⁷ of the Catholic University (Pontificia Universidad Católica) of Santiago (case n° 7) is dedicated to the study of the wilderness (figure 4) and subantarctic settlement. Infrastructure created in 2010 on state land (5079 hectares) at the mouth of the glacial valley of the Río Exploradores is a base camp for research in the field of natural science of isolated forests and lakes. The infrastructure allows researchers from different faculties to reside for a few days a year with international students or guests. This case has inspired other state and private organizations to create field laboratories as part of their conservation or tourism development projects.

Illustration 4. Mountain areas as a location for educational training; students and professors are informed of the infrastructure of the Patagonia-Exploradores scientific station of the Catholic University of Chile, in 2019.



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21 The case studies show that different resources are mobilized in the mountain, periglacial, forest, wetland, or coastal environments of the Andes. The scientific disciplines addressed are very diverse: biology, geology, climatology, oceanography, glaciology, hydrology, archaeology, anthropology, geography, territorial planning, etc. The sites are areas off the beaten path, attractive because of their ecosystems, geological, cultural, or historical importance and where actions of protection, conservation and development seem necessary. The environmental and climatic problems are strong and linked to protected areas (Laguna San Rafael National Park, Queulat or Patagonia). The nature of stakeholders, operators of the scientific resource, is multiple: university centers or laboratories, groups of researchers, foundations, NGOs or tourism entrepreneurs.

Table 1. Seven initiatives that use scientific resource in the region of Aysén, Chilean Patagonia

ID.	Name of the initiative	Leading Organization	Geographical area	Scientific Resource	Field activities
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1	Patagonian Archipelagos	Public-private Research center (CIEP)	Coastal mountain range of the Aysén region	Plant and animal biology, geology, geomorphology, climatology, oceanography & archaeology Scientific	Scientific mediation, participatory research, dissemination workshops, guided tours and tourism training
2	Ofqui Isthmus Expedition	Research Center & Universities (CIEP & others)	Northern Patagonian Ice Fields, Laguna San Rafael & Glacier Pi—XI	Animal biology, geology, glaciology, geomorphology, geography, oceanography and history	Data collection, participatory research, dissemination workshops
3	Tour Laguna San Rafael	Tourism operator	Laguna San Rafael National Park & Ofqui Peninsula	Plant and animal biology, glaciology and oceanography, history and anthropology	Knowledge sharing, creation of interpretation routes, guided sports adventures.
4	Tourism with a Magnifying Glass (Turismo con Lupa)	University (Austral de Chile)	Queulat National Park, Andes deciduous forests	Plant biology, sociology	Data collection, enhancement of the environment, training of students and guides, field trips
5	Parc Patagonia	Private foundation and non-profit organization	Chacabuco Valley, Cochrane, Aysén, Chili	Plant and animal biology, geology, hydrology and archaeology	Data collection, participatory census, museum restitution, trail creation, taxonomy training
6	Laguna Caiquenes	Non-profit organization and regional museum	Laguna Caiquenes, municipality of Tortel, Aysén	Plant and animal biology, climatology	Data collection, interpretive trail development, community workshops
7	Patagonia — Exploradores Scientific Station	University (Católica de Chile)	Coastal range, austral temperate ecosystem.	Plant biology, geography, political science, agronomy, history, architecture	Data collection, local conferences, university training, knowledge dissemination

Table 2. Objectives in the use of scientific resource within seven initiatives of the region of Aysén, Chile.

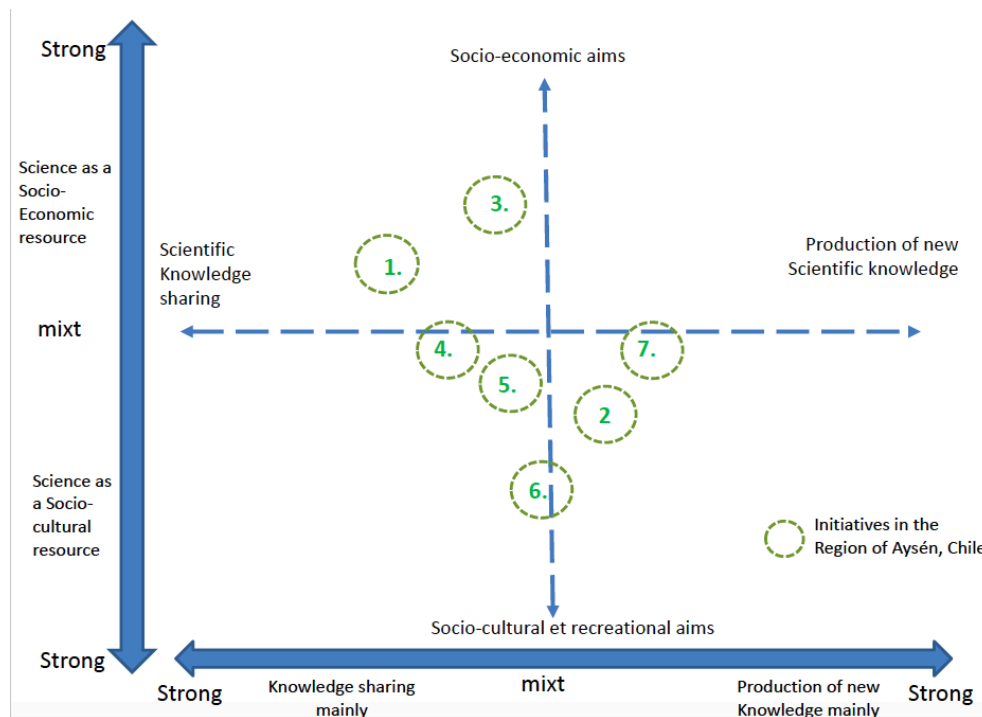
ID.	Project Name	Producing and sharing knowledge		Creating products and sharing recreational experiences	
		Producing scientific knowledge (research)	Sharing knowledge (dissemination, mediation, participation)	Socio-economic aims (Products with added value)	Socio-cultural aims (non-profit products, recreational and educational)
1	Patagonian Archipelagos	High (Diagnosis, literature review)	High (Interpretation of scientific data)	High (Creation of commercial products)	Low (Scientific workshops, educational actions)
2	Ofqui Isthmus Expedition	Strong (data collection)	Low (conferences)	Low (use of local services)	Low (sports and scientific events)
3	Tour Laguna San Rafael	Low (monitoring)	High (knowledge transfer)	High (creation of tourism products)	Low (activities with schools)
4	Tourism with a Magnifying Glass (Turismo con Lupa)	Low (monitoring)	High (knowledge transfer)	Medium (paid training)	Medium (community education)
5	Parc Patagonia	Medium (species surveys)	High (museum creation and interpretive trails)	Low (visitor services)	High (education and outdoor trails)
6	Laguna Caiquenes	Medium (species surveys and censuses)	Medium (knowledge transfer, interpretive trails)	Low (creating a tourism location)	High (education and outdoor trails)
7	Patagonia — Exploradores Scientific Station	High (Data collection)	Low (Conferences)	Low (fee-based university residency)	Medium (Community education)

Discussion

- 22 These case studies show that in a mountain territory, a plurality of activations of the scientific resource exists, depending on the places, issues, and objectives of the project leaders. The scientific resource appears as specific and is valued in tourism through
1. production of scientific knowledge (data collection for publications with a more or less strong participation of local actors),
 2. sharing of acquired knowledge (scientific meetings, congresses, seminars, or data restitution spaces organized for visitors),
 3. socio-cultural activities, involving researchers and non-scientists (outdoor data interpretation, tours, animations and educational workshops) and
 4. activities with a more socio-economic aim (guided tours of sites with specialists, paid training courses for students, professionals or tourists, recreational adventures with scientific content).
- 23 Table 2 shows how each initiative studied is positioned according to specific objective, emphasizing a primary but sometimes multiple ways of valuing science.
- 24 Within some expeditions or scientific field trips, such as to Ofqui Isthmus (case n° 2), Patagonia Park (n° 5), Laguna Caiquenes (n° 6) or the Patagonia-Exploradores scientific station (n° 7), the acquisition of scientific knowledge is a priority. Data collection, reports and publications contribute to a better understanding of issues within the territory and create more favorable conditions for development. In other projects, The Archipelagos of Patagonia (n° 1), Tourism with a magnifying glass (n° 4), Patagonia Park (n° 5) and Laguna Caiquenes (n° 6) the emphasis is put on sharing knowledge through educational activities and interpretation of available data. When valued by the community and visitors, signposted routes or guided treks and local museums are established in the territory and areas of importance. Commercial products, such as tours offered by local operators in the Patagonia Archipelagos network (n° 1) or in the Laguna San Rafael National Park (n° 3) or non-profit, such as animations and workshops for the community on the Laguna Caiquenes (n° 6), Tourism with a magnifying glass (n° 4), Patagonia Park (n° 5) and Patagonia Exploradores Station (n° 7) projects, reinforce the attractiveness of a territory.
- 25 Various actors mobilize scientific resource in specific ways (Pecqueur, 2002). They invent products with high added value and guide the socio-cultural development of the territory (François, Hirczak and Senil, 2006). All of this contributes to the creation of a tourist destination with quality products. This is what the CIEP research center, the regional government of Aysén and the Inter-American Development Bank envisioned through the Patagonian Archipelagos project with the creation of a destination for scientific tourism (Bourlon, 2020a). The diversity of intentions within the initiatives reveals that science can be valued in different ways according to polarities, stemming from declared aims: to strengthen research and the acquisition of scientific knowledge, to promote mediation and citizen experimentation, to help create tourist services and products, or to enhance knowledge for cultural and recreational purposes. However, the objectives are often hybrid due to the cross-cutting issues identified by the project leaders (Figure 3). None of the projects is exclusively focused on research, but several bring new scientific knowledge and the majority have an interest in mediation and

active knowledge sharing. The socio-economic issue seems to be less important in this territory than the social, educational and/or environmental concerns.

Figure 2. Initiatives in the Aysén region of Chilean Patagonia according to their focus and objectives in activating scientific resource.



- 26 Since 2008, scientific tourism in Patagonia has been proposed as an innovative strategy that can strengthen both field research and the attractiveness of the territory (Mao, Bourlon, 2016). Scientific research and tourism advance the exploration process of this geographically isolated land initiated by naturalists in the nineteenth century. Low accessibility and high costs of transportation still limit the discovery of the territory. By increasing knowledge acquisition and promoting the transmission of scientific data to the community, scientific tourism initiatives support territorial development through promoting scientific, educational, and cultural travels. As shown by the mediation methods existing in the Alps (Viallette, Mao and Bourlon, 2021), the mountain area is a favorable landscape for innovative development based on scientific tourism. It is

1. an open-air laboratory, a support for scientific research,
2. a mediation space for research, a support for participatory and citizen science,
3. an ecotourism area and favorable support for interpretation for visitors, and
4. a learning place and support for environmental education.

- 27 Initiatives that combine research and mediation contribute to the improvement of the tourism offerings and generate significant economic and cultural benefits for research centers, training centers, museum spaces and tourism entrepreneurs. By strengthening research, the diversification and increase in quality of the tourism offerings supports innovative development of isolated territories (Gravari-Barbas, 2017). The transformation of a scientific resource supports new social representations of the destination as influenced by local operators (Durand, Landel, 2020). This dynamic

makes sense in a global context of climate change challenges and regarding the international sustainable development goals (Marcotte, Bourdeau and Sarrasin, 2017). Other mountain environment and nature borderlands could support other ways of activating science for territorial development.

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ABSTRACTS

The region of Aysén, in Chilean Patagonia, is an isolated natural mountainous area, which relies on science for its tourist and territorial development. Project leaders are promoting specific scientific research underway in the territory. Science is mobilized as a resource in the creation of products, recreational and educational activities, commercial or non-profit. These initiatives are carried out by research centers, universities, entrepreneurs, and non-governmental organizations and reveals that the acquisition and sharing of scientific knowledge creates local dynamics that contribute to the tourism and territorial development. By nature, the mountain environment is a resource and laboratory for scientific research. It is also a favorable environment for citizen science and an ideal support for mediation and scientific interpretation. Scientific tourism initiatives promote a diversification and an added value that increases territorial assets and the attractiveness of an isolated but evolving area.

La région de Aysén, en Patagonie chilienne, est un espace naturel montagnard, isolé, qui mise sur la science pour son développement touristique et territorial. Des porteurs de projet valorisent de manière spécifique la recherche scientifique menée sur le territoire. La science est mobilisée comme ressource dans la création de produits, d'activités récréatives et éducatives à but lucratif ou non. Les initiatives menées par des centres de recherche, universités, entrepreneurs et organisations non gouvernementales, montrent que l'acquisition et le partage des connaissances scientifiques créent des dynamiques qui participent du développement touristique et territoriale. L'espace montagnard est une ressource en tant que laboratoire pour la recherche scientifique. Il peut être un milieu pour la science citoyenne, support pour la médiation et l'interprétation scientifique. Il apparaît que les initiatives de tourisme scientifique favorisent la diversification ou la montée en qualité de l'offre territoriale et l'attractivité d'un espace isolé en transition.

INDEX

Mots-clés: développement territorial, ressource scientifique, tourisme, attractivité, médiation

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AUTHORS

FABIEN BOURLON

UMR PACTE – Université de Grenoble Alpes

YANNICK VIALETTE

UMR PACTE – Université de Grenoble Alpes

PASCAL MAO

UMR PACTE – Université de Grenoble Alpes, Centro de Investigación en Ecosistemas de la Patagonia