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The market for climate services in the tourism sector – An analysis of Austrian stakeholders' perceptions

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ABSTRACT

Climate services (CS) are promoted as a means to support decision-making processes in order to better prepare and adapt to the risks and opportunities of climate variability and change. The current market for CS is still in its early stages. In this paper, we report the findings from our recent investigation into the actual and potential market for CS in the Austrian tourism sector. In close collaboration with tourism stakeholders and CS providers, we explored main barriers hampering the actual use and effectiveness of climate services and identified potential drivers to support further product development and widespread uptake of CS.

Despite the high vulnerability of tourism to climate variability and change, the actual use of CS among Austrian tourism stakeholders is rather limited. The main barriers to the use of CS in tourism include widespread low levels of risk awareness, a certain degree of risk denial, a lacking sense of urgency due to (yet still) little financial pressure, and rather short business decision cycles, which lead to a low prioritization of climate issues. Furthermore, lack of knowledge of existing services and their benefits, lack of applicability, and distrust in climate services restrict their use.

Recommendations for an enhanced uptake of CS thus include the improved demonstration and communication of their added value. In addition, the market would benefit from an increase in intermediaries who bridge the gap between research and applicability. It is further recommended to increasingly integrate climate information into existing services and products already in use.

Practical Implications

Given the societal and economic challenges generated by climate change, it becomes increasingly important to include climate information in every day decision making. Climate services (CS) are helping organizations and companies to mitigate, adapt to, and become more resilient to climate change. The market for climate services, however, is still in the early stages of development, with presumed gaps existing between supply and demand.

In this study we identified the constraints and enablers shaping climate services uptake in the tourism sector. By means of interviews and workshops with tourism stakeholders from Austria we explored the main barriers hampering actual market uptake, identified user needs and assessed CS options and market development needs to improve the match between climate services supply and demand.

Current use of climate services

The use of weather services – in particular, publicly available and tailored forecasts of up to ten days – is quite common in the tourism sector, but the use of climate services is still rather limited. Currently, customized climate services are used mainly by a few ski resorts (e.g. studies on current and future snow reliability and snowmaking potentials, climate proofing of investments etc.) and provincial governments or tourism associations (e.g. commissioned regional studies on climate change impacts).

User needs

Tourism stakeholders require high spatial resolution, i.e. climate change impact assessments and adaptation strategies at the local and regional levels, presented in a simple and compact way.

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Consulting is considered important, i.e. guidance is needed on how to interpret scientific results, what they mean for a particular tourism region, and how to prepare for and adapt to a changing climate. Since climate is just one among many factors influencing future development, an integrated assessment including general market trends, demographic changes, changes in travel behaviour etc. is needed.

Overall, tourism stakeholders show higher interest in short-term and seasonal services than in long-term projections. This holds true in particular for tourism service providers, but also for tourism associations and public authorities, since their planning horizons usually do not exceed five to ten years (e.g. in tourism strategies).

	USER NEEDS
Applicability & Format	• High spatial resolution: information at local/regional level • Simple & compact – easily understandable • Consultancy services
Short-term	• Improved weather forecasts (and seasonal forecasts) • Tourism associations/ Hospitality: activity recommendations based on weather forecasts
Strategic planning	• Ski resorts: modelling improvements (e.g. foehn events, extreme precipitation, snowmaking) • Public administration: advice on adaptation strategies and investments planning (e.g. cycling infrastructure)
Research	• General market trends, travel behavior - in relation to climate (change) • Impacts on summer tourism and shoulder-season tourism • Connections between tourism and related areas, such as agriculture, transport, environment

Main barriers

The main barriers to the use of CS in the tourism sector include wide-spread low levels of risk awareness, a lacking sense of urgency due to (yet still) little financial pressure, and rather short business decision cycles, which lead to a low prioritization of climate issues. Furthermore, limited capacity of users, lack of knowledge of existing services and their benefits, lack of applicability, and distrust in CS restrict their use.

	BARRIERS
Awareness	• Risk denial and lack of risk awareness • Lack of knowledge of existing climate services and their benefits
Priorities	• Climate is only one issue tourism businesses have to deal with and requires additional resources besides their daily business • Low financial pressure (degree of suffering) • Absent long-term risk management/short business decision cycles • Higher interest in short-term services
Capacity	• Limited resources to use or interpret climate data and to provide business/region-specific data • Financial constraints
Applicability of CS	• Too coarse spatial resolution • Lack of user-friendliness (too complicated scientific language)
Lack of trust	• Conflicting messages in the media cause skepticism • Uncertainty of climate scenarios and lack of knowledge on how to interpret climate data

Conclusions and recommendations

Awareness-raising of climate risks remains one of the main drivers for CS uptake. However, absent long-term risk management still hinders the use of CS. Due to rather short business decision cycles, many interviewed stakeholders showed, if at all, a higher interest in weather services and seasonal products than CS. Nevertheless, dealing with weather variability and using weather services may also increase the interest in climate services to some extent and thus could be used as potential leverage for CS uptake. The use of CS in the tourism sector, however, may be more of a concern for tourism service providers with high investment needs in infrastructure and high vulnerability.

In order to increase their use, climate services and their benefits need to be better demonstrated and communicated. In general, the willingness to pay for CS seems to be rather low, which is also related to the degree of suffering. Better communication and demonstration of the benefits of CS use could increase the willingness to pay for tailored services as well.

Overall, the market would benefit from a more diversified set of CS providers and more intermediaries who bridge the gap between research and applicability. Currently, CS are mainly provided by research institutions alongside their research and teaching activities. Hence, too little emphasis is put on product development and design, sales and marketing as well as consulting activities.

Weather and climate data on their own do not provide a sufficient decision basis for stakeholders, as they are just one of many factors influencing tourism demand. Stakeholders emphasize the need for market research about demand in relation to climate (change), considering also general trends in leisure activities as well as demographic changes. This fact also supports the recommendation for increased integration of climate information into decision-tools and services already in use by the tourism sector.

1. Introduction

With growing awareness of the risks and opportunities that climate change presents, the use of climate knowledge and information in decision making, policy and planning is becoming increasingly important. Climate services (CS) are intended to facilitate climate adaptation, mitigation, and disaster risk reduction. In the EU Research and Innovation Roadmap for Climate Services (European Commission, DG for Research and Innovation, 2015) climate services are described as "*the transformation of climate-related data – together with other relevant information – into customized products such as projections, forecasts, information, trends, economic analysis, assessments (including technology assessment), counselling on best practices, development and evaluation of solutions and any other service in relation to climate that may be of use for the society at large*". Within this rather broad definition of climate services, Hamaker et al. (2017) separate *climate data services* – climate data records, projections, forecasts, and climate models – from *adaptation, mitigation, and disaster risk management services*, which include vulnerability and risk analyses, recommendations for climate change action, and more refined information.

Climate services and their role in climate change mitigation and adaptation have increasingly been subject of research in the recent past (cf. Brasseur and Gallardo, 2016; Bruno Soares et al., 2018; Buontempo and Hewitt, 2018; Cavelier et al., 2017; Hewitt et al., 2012; Street, 2016; Vaughan et al., 2018; Vaughan and Dessai, 2014). However, the market for these services is still in an early and premature stage of development. Brasseur and Gallardo (2016) identified the following reasons for the, so far, limited success of climate services: insufficient awareness by societal actors of their vulnerability to climate change, the lack of relevant products and services offered by the scientific community, the inappropriate format in which the information is provided, and the inadequate business model adopted by climate services. Harjanne (2017) also points to some more fundamental problems of CS uptake, insofar as not all climate-related challenges benefit from or are dependent on more information. In mitigation and adaptation, many barriers are psychological, institutional, socio-economic or infrastructure-related. In this paper, we report on the findings from our recent investigation into the actual and potential market for CS in the Austrian tourism sector. The analysis was part of the two Horizon 2020 market research projects EU-MACS – 'European Market for Climate Services' and MARCO – 'Market research for a Climate Services Observatory'.

Tourism is among the most weather- and climate-sensitive sectors of the economy and hence vulnerable to climate variability and change. Thus, one would, in principle, expect high potential for services offering sector-specific and tailored climate information for decision making. In close collaboration with tourism stakeholders and CS providers, we identified the main barriers hampering the actual use and effectiveness of climate services in the tourism sector as well as potential drivers to support further product development and effective widespread uptake of climate services. We carried out a detailed review of climate services in the tourism sector and conducted interviews with climate services providers and (potential) users to collect information on the perceived climate risks, the current use of climate services, perceived barriers and user needs. In a workshop, bringing together the provider and user side, previous findings and assumptions were verified and further requirements and needs of end-users discussed.

Previous studies have analyzed climate risks, risk perception and related information needs in the tourism sector and ski tourism in particular. Abegg et al. (2017) identified a gap between the scientific community and the industry on the perceived urgency to act and adapt. It has also been pointed out that the diverse industry has varied means and differing capacities to adapt (Bicknell and McManus, 2006; Moreno-Gené et al., 2018; Steiger et al., 2017). Decision-relevant information and effective dialogue have been suggested as important tools in adaptation in the tourism sector (Steiger et al., 2017). The capacities and needs for climate services specifically have been studied by Scott and Lemieux (2010) and Scott et al. (2011). The authors give an overview of climate influences on the tourism sector and potential uses of weather and climate information by tourism operators and travel planners.

Several European projects like CLIM-RUN (www.climrun.eu), EUPORIAS (www.euporias.eu) and SECTEUR (https://climate.copernicus.eu/secteur) also address the development of climate services in different economic sectors, amongst others, in the tourism sector. Copernicus Climate Change Service (C3S, https://climate.copernicus.eu/european-tourism) has also identified tourism as one of the key climate-sensitive sectors and is planning to launch a user-driven climate information system for the sector in 2019.

In the CLIM-RUN project, Dubois et al. (2013) conducted a survey among Mediterranean tourism stakeholders and found that the current use of CS in the Mediterranean tourism sector is low, despite some obvious interest. Stakeholders faced difficulties to express their needs due to low awareness or lack of vision of the potential value of climate service. SECTEUR's multi-sector user survey on the requirements of climate information and impact indicators across Europe revealed that alterations to natural ecosystems (e.g. reduction in wetlands), water quality and changes in winter/summer overnight stays were the most frequently used climate-related information in tourism. Beyond requests for additional information and indicators, users called for higher spatio-temporal resolutions, better explanations of what the data showed and more accessibility (Alexander et al., 2016a).

EUPORIAS aimed at developing CS prototypes which would operate on seasonal and decadal time scales. One tourism related case study was PROSNOW, which endeavored to deliver a seamless sub-seasonal to seasonal snow prediction system specifically tailored for the ski industry in the Alpine area (Buontempo et al., 2016). PROSNOW is currently being further developed in the ongoing H2020 demonstrator project PROSNOW (2017–2020, www.prosnow.org).

This paper strongly focuses on the more downstream part of the CS value chain and in particular on the perspective of potential end-users. Looking beyond data requirements and key indicators it deals with end-users' needs in a broader sense as well as barriers to CS provision and uptake in the tourism sector, with a special focus but not limited to mountain winter and summer tourism. The paper is structured as follows: section 2 describes the applied methodologies and identified stakeholder groups in the tourism sector. The results, including the climate risk perception of the interviewed tourism stakeholders, an overview of existing and potential CS in the tourism sector, the identified user needs as well as the perceived barriers to CS provision and use, are presented in section 3. In section 4, we discuss the findings and make recommendations.

2. Methods

Different methods were applied to analyze the market for climate services in the tourism sector. We began with detailed market review by means of literature research. These were followed by interviews with climate services providers and (potential) users. In the interviews we further explored the constraints and enablers shaping climate services uptake in the tourism sector. In a workshop, which brought together the provider and user side, the earlier findings from the review and interviews were validated and further requirements and needs of end-users discussed.

The interviews mentioned above were semi-structured and aimed at identifying the current supply and use of CS in tourism, perceived barriers to the provision and use of CS, and possible unmet user needs. In addition, we asked tourism stakeholders about their risk perception and stakeholder networks. The risk perception helps to contextualize the given answers to current use, barriers and user needs. Tourism stakeholders were asked to rate the perceived current and future vulnerability to climate risks of their own business or the tourism sector as a whole on a scale between 1 (not vulnerable) to 5 (very vulnerable). The questions about their stakeholder networks aimed at validating the tourism stakeholder mapping and identified stakeholder groups. Our interview guidelines, which were inspired by questionnaires of Goodess (2013), Göransson and Rummukainen (2014), Manez et al. (2013), and Alexander et al. (2016b), can be found in the Supplementary Material.

Sixty tourism stakeholders were contacted, of which 35 persons responded and 21 agreed to an interview. The potential interview partners were chosen by using existing personal contacts and internet research. We selected tourism stakeholders from different regions in Austria, covering the most important stakeholder groups as identified in the stakeholder analysis (see Fig. 1).

In addition to tourism stakeholders, we contacted 19 researchers and consultants in the field of climate and tourism. From these we finally conducted an interview with 11 persons to examine the current supply of CS, perceived barriers to providing and using CS, and perceived user needs. We selected the potential interview partners based on known literature in this field, personal contacts and internet research. Table 1 lists the contacted and interviewed tourism stakeholders and CS providers by type of organization. The interviews were held in German language, transcribed and content-analyzed.

In a next step, a stakeholder workshop in Graz, Austria, was organized to deepen the understanding of user needs and barriers, validate the findings from the interviews and identify enablers for CS market enhancement. The workshop allowed for an exchange of views on climate services use and provision, obstacles and enablers between the different types of stakeholders from the tourism industry and CS providers. The workshop consisted of three parts: the first part aimed at introducing the topic by showing some examples of CS and discussing first findings from the interviews regarding barriers and enablers of CS in stakeholder comparison. The second part was dedicated to Constructive Technology Assessment (CTA), an approach developed for the prospective shaping of technology, here applied to the probing of alternative scenarios for climate service innovations, not a technology per se (Konrad et al., 2014; Rip, 2018). An emerging knowledge-intensive service may face the same kind of uncertainties that occur with technologies and thus the same approach can be used to enable anticipatory learning for climate service market research. The CTA part of the workshop

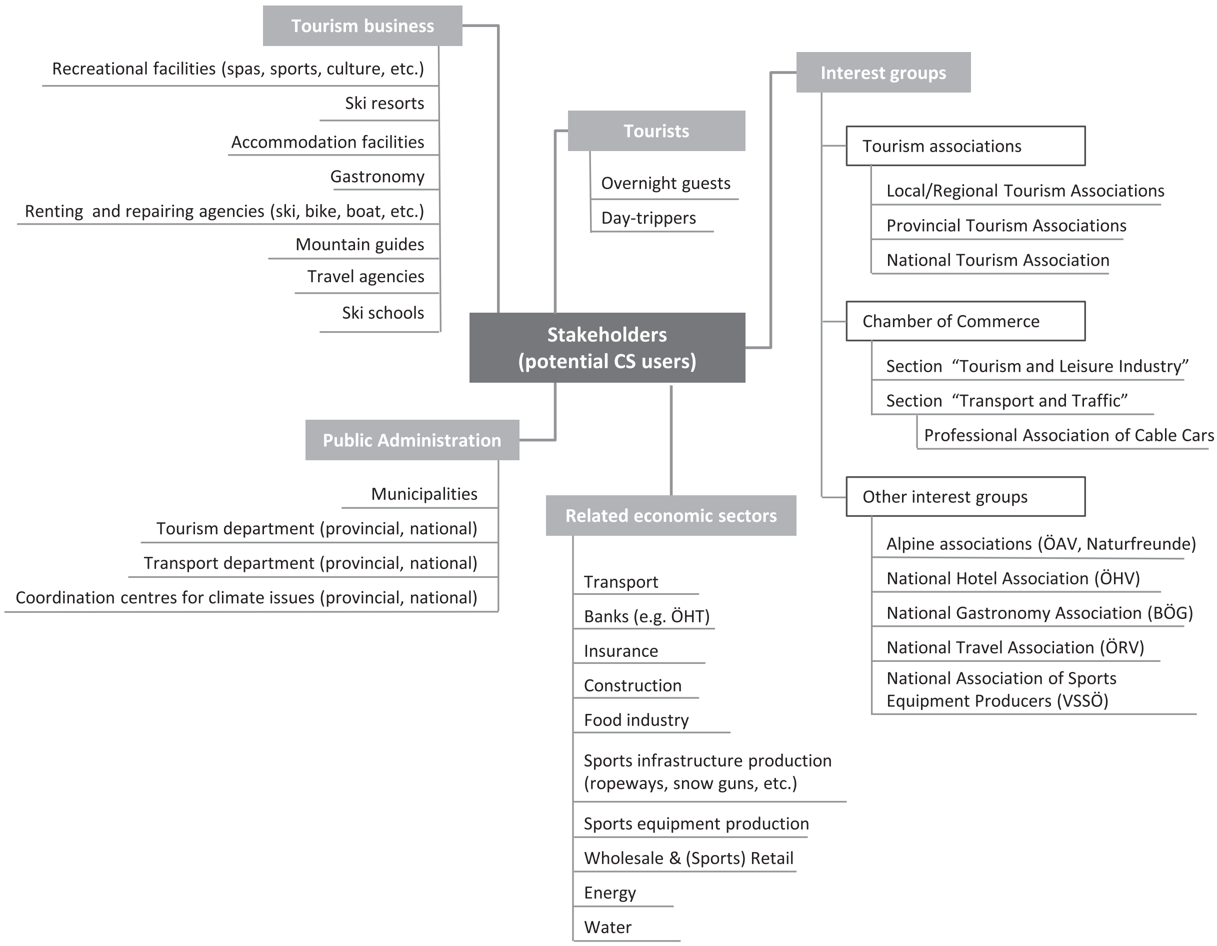

Fig. 1. Stakeholder mapping – Potential CS users in the tourism sector.

offered a typology of four scenarios for climate service development, structuring the variety in potential climate services while at the same time giving ample space for discussion of aspects stakeholders find important: 'maps & apps', 'expert analysis', 'climate-inclusive consulting', and 'sharing practices'. The scenarios had two dimensions, one emphasizing 'customization', the other 'integration'. The customization dimension differentiated between services that were tailored to the needs and wishes of a specific customer, and services that were developed as a generic offering to a larger group of customers (see Table 2). The typology (CTA) is based on prior research in the project, on prior workshops and typology use in the project for other sectors, as well as insights from service and general innovation scholarship. Details on the approach, the CS business scenarios underlying the typology, and implications of the results can be found in Visscher et al. (this issue).

CTA represented the first of two applied approaches aiming at the joint exploration of value propositions. In the final part of the workshop, the value proposition canvas (Osterwalder et al., 2014) was applied to discuss two typical business cases, one specifically with regards to ski lift operators' views and one regarding the situation and demands of local tourism organizations.

In total, we sent out 40 workshop invitations – to the interviewed (potential) CS users and selected CS providers and to some new contacts – and 10 stakeholders participated in the workshop (Table 3). As part of the EU-MACS project, parallel work was also conducted among tourism stakeholders in Finland. In Finland, 12 representatives of tourism sector were interviewed and a pilot survey probing different climate services was conducted with eight respondents. The Finnish results are excluded from the analysis in this paper to maintain the focus and ability to contextualize the results.

3. Results

The following subsections present the results from the CS review, the interviews and the workshop. They include the stakeholders' risk perception (3.1), an overview of existing and potential applications for climate services in the tourism sector and the current use of CS in Austria (3.2), as well as the identified user needs (3.3) and barriers to CS provision and use (3.4).

3.1. Risk perception

Climate change is perceived as a risk for winter tourism by most interviewees, but opportunities for mountain tourism in summer are mentioned as well. The surveyed stakeholders believe that Alpine summer tourism destinations may gain competitive advantages due to cooler temperatures, especially in very hot summers. In terms of economic value added, however, summer tourism is not seen to be able to compensate losses in winter tourism as tourist expenses are higher in winter.

No person interviewed was skeptical of climate change, but they partly identified skepticism and a lack of risk awareness when generally talking about the sector, in particular within the ski area operators. This is underlined by the following statement of an interview partner from the Chamber of Commerce (department of 'Tourism and Leisure Industry'): "*We try to communicate the climatic trends to our members. However, the interest in climate change topics is very low. There is a kind of resistance to advice. […] Nevertheless, we try to point out that climate change should be considered in investment decisions*".

The perceived risk level of the interviewed stakeholders depends on

Table 1
Contacted and interviewed tourism stakeholders and CS providers.

	contacted	interviewed
Tourism stakeholders	**60**	**21**
National tourism association	1	
Provincial tourism associations	9	7
*(Vienna, Burgenland, Upper Austria, Lower Austria, Styria, Tyrol, Vorarlberg)**		
Regional tourism associations	7	2
(2 in Styria)		
National public administration – tourism department	1	
Provincial public administration	8	1
(Burgenland – tourism department)		
Chamber of Commerce	2	1
(Styria – department 'Tourism and Leisure Industry')		
National hotels association	1	1
Other interest groups	2	
Hospitality sector	9	2
(1 Marketing manager of a 5 Hotel in Tyrol; 1 Hotel manager of hotels in the wine regions in Styria and Lower Austria)*		
Ski resorts	10	5
(4 in Styria and 1 in Lower Austria)		
Recreational services	3	1
(Styria – Spas & Swimming pools)		
Sports retail	4	
Sports equipment production	2	1
Banks	1	
CS providers/researchers	**19**	**11**
University or research institute	10	6
(4 Hydrology/Snow modelling, Meteorology; 1 Landscape development, recreation and conservation planning, participatory planning processes; 1 Travel behavior, sustainable tourism development)		
National meteorological service	1	1
(Research coordination)		
Private business	7	3
(2 Private weather services; 1 Tourism consultancy)		
Other	1	1
(National park)		

* The additional information in brackets refers to the interviewed stakeholders.

the type of stakeholder and their location. Tourism associations in the eastern – less mountainous – provinces of Austria perceive the current climate vulnerability in their regions to be rather low due to the high diversity of offered tourism types and the minor role of ski tourism. On the other hand, tourism associations in winter tourism dominated provinces in western Austria assess their region's current climate vulnerability at a higher level. Many of them have already successfully combined wellness and skiing. This increasing competitiveness between tourism regions was also referenced by the interviewee from Burgenland tourism in the east of Austria, who said that "*even though Burgenland is currently not that vulnerable to climate variability compared to other regions, its position and niches in the tourism market could increasingly be challenged due to adaptation measures taken by other regions.*"

Table 3
Workshop participants in Graz (Austria).

Workshop participants	
Ski resorts – Styria, Lower Austria	3
Local tourism association – Styria	1
Provincial public administration – Styria (climate protection department)	1
Provincial public administration – Burgenland (tourism department)	1
Snow management center Tyrol	1
Climate Change Centre Austria	1
National weather service (CS provider)	1
Private weather service (CS provider)	1

The highest current vulnerability is felt by interviewed stakeholders from ski resorts and the interviewed sports equipment producer. The perceived vulnerability among the interviewed ski resorts is diverging, though. Those interviewed ski resort operators who do not use customized climate services rate their vulnerability lower. The interviewed persons from the hotel sector perceive their current climate vulnerability as quite moderate, with differences in the rating across tourism regions (higher in alpine regions compared to non-alpine regions).

Most stakeholders expect a slight increase or no changes in the climate vulnerability of their tourism region in the future. One interviewee believes that the vulnerability will decrease in the future as the tourism industry adapts to climate change and, hence, the weather and climate dependency of tourism decreases.

Overall, the interviewed stakeholders seem to be more concerned about short-term impacts of adverse weather conditions and inaccurate weather forecasts rather than long-term changes in the climate. The interviewees refer to the high flexibility of tourists in case of adverse weather conditions and report an increase in last minute bookings due to the widespread use of weather apps.

Diversity of offered tourism activities could help to reduce a company's climate vulnerability. A trend to all-season tourism is observed already by the interviewed stakeholders. Some interviewees, however, indicate that climate change might be just one of several reasons for an increase in summer tourism, like trends in sports, which change and evolve constantly.

3.2. Climate services in the tourism sector

Depending on the temporal scale, weather and climate information is being utilized in a wide range of decision-making contexts by tourism operators, tourism planners and tourists. The field of application for tourism operators and planners ranges from site location analysis, operational management to strategic planning and investment decisions. Weather and climate have broad significance to tourist decision making and the vacation experience in terms of destination choice, timing of travel and activity planning (cf. Scott et al. 2011).

3.2.1. A mapping of existing and potential climate services

Fig. 2 gives an overview of existing and potential applications for

Table 2
CTA scenarios for climate services.

	Generic	*Customised*
Focused	Maps & Apps: ● Generic climate services ● Freely or cheaply available … ● … to all users	Expert Analysis: ● Scientific, professional, commercial, ● monodisciplinary climate services ● Tailored to specific decisions and ● decision-makers
Integrated	Sharing Practices: ● Mutual services on … ● … adapting and mitigating climate change in specific environments ● Available to all users	Climate-inclusive Consulting: ● Professional, commercial and … ● … transdisciplinary climate services ● Tailored to specific decisions and ● decision-makers

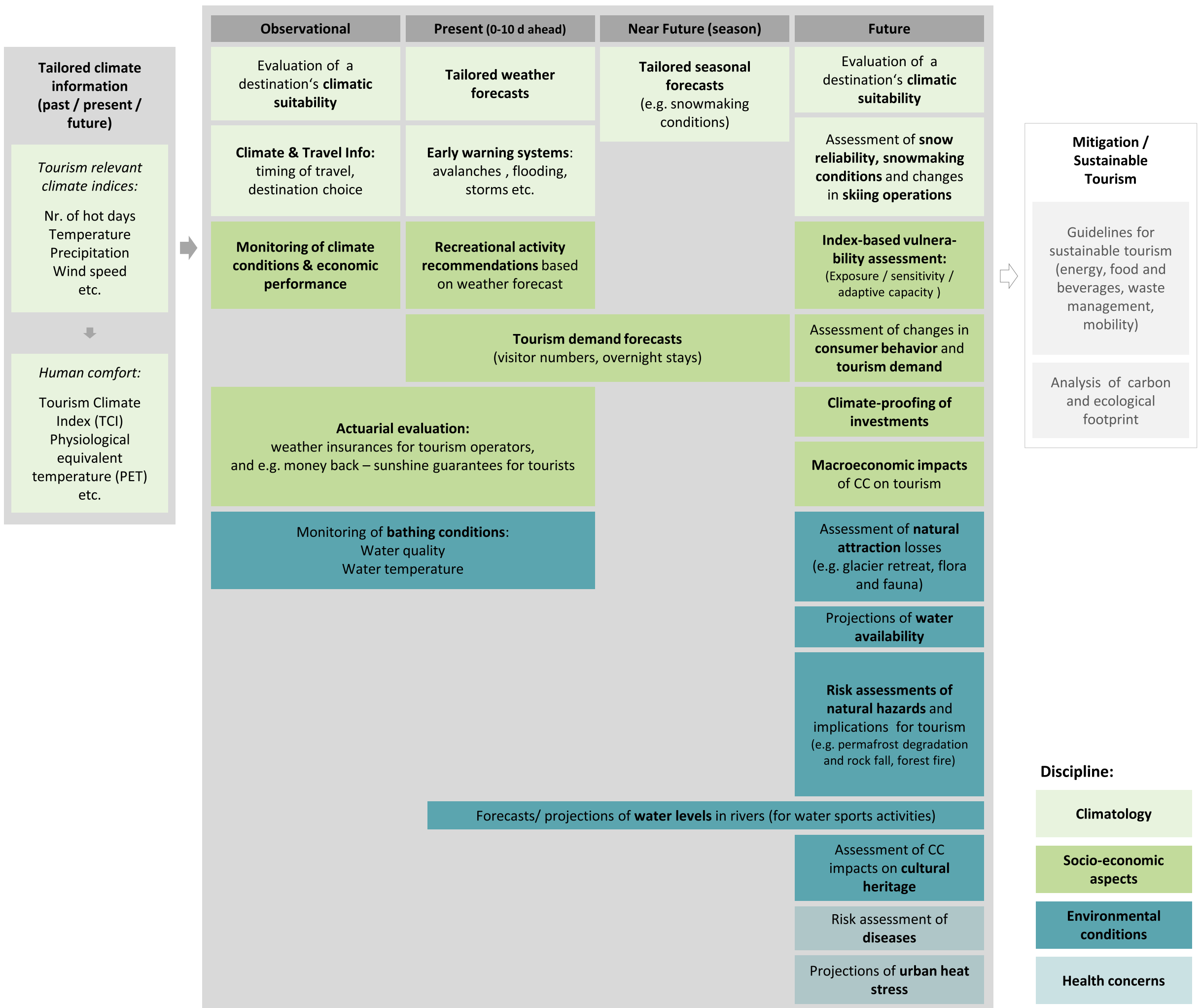

Fig. 2. A set of themes for providing weather and climate services in the tourism sector.

weather and climate services in the tourism sector. The information is drawn from the literature and the conducted interviews. Depending on the use case, different spatial scales and formats are applied.

Climate information is the basic input for a range of climate services in the tourism sector. An analysis and mapping of changes in climate indicators (e.g. tourism climate index (TCI)) provides basic knowledge on climate change impacts on tourism. Observational or climate scenario data is used for climatic reviews, i.e. the evaluation of a destination's climatic suitability. A destination's climatic suitability can also be evaluated with respect to the timing of e.g. sports events. One use case refers to the timing of a FIS Alpine ski world cup race, as mentioned by an interviewed CS provider.

Climate statistics based on observational data serve as information for tourists concerning the timing of travel and the destination choice. For the planning of new tourism facilities and attractions, a destination's climatic suitability may be evaluated on the basis of climate scenario data. Observed climate data may also be (statistically) evaluated together with economic performance indicators (visitor numbers, revenues etc.) for a selected time period (months, seasons or years) and presented e.g. in form of monitoring fact sheets or online formats. This monitoring may be relevant for individual tourism businesses or tourism destinations.

Historical climate data is also the typical foundation for the emerging application of weather derivatives and index insurance products to reduce weather risks in the tourism sector. As Scott et al. (2011) stated, participation of the tourism sector in the weather derivatives market has remained rather limited. Nonetheless, there is tremendous potential for innovative partnerships with the financial services sector to develop highly customized contracts aimed at preventing or reducing weather-related revenue loss (Scott et al., 2011). Actuarial evaluations can also be used to define optimal conditions for e.g. 'Money-back sunshine guarantees' for tourists. These have begun to be offered e.g. for destinations in the south of France by French travel agents in cooperation with the insurance company Aon France (Scott et al., 2011). Similar money-back deals have been offered by the ski region Davos Klosters in Switzerland[1] or Heide Park Resort in Germany[2].

Customized CS based on snow simulations are currently the most frequently used service in Austria. Several ski resorts have already commissioned a study on projections of snow reliability and snowmaking conditions for their particular ski region. Two particular services in use are described in more detail in section 3.2.2.

In the short term, it is quite common to use weather forecasts for operational snowmaking management (highly resolved forecasts on a commercial basis, provided by the national meteorological service or private meteorological service companies). Tailored weather forecasts and early warning systems are used by tourism associations and hotels to provide local weather information on their own websites or hotel

[1] www.skimagazin.de/de,de/neuschnee/davos-klosters-sonne-oder-geld-zurueck,article00007164.html, [accessed: 14 November 2017]

[2] www.heide-park.de/infos/schoenwetter-garantie.html, [accessed: 14 November 2017]

gazettes (besides freely available information directly used by tourists). Tailored weather forecasts are also used to recommend recreational activities suitable for the prevailing weather conditions.

Assessments of consumer behavior and behavioral adaptation mainly result from funded research projects. Surveys and discrete choice experiments are typically used to investigate tourists' likely responses to various destination scenarios under possible adaptation strategies to climate change (cf. Pröbstl and Jiricka, 2007; Landauer et al., 2012; Unbehaun et al., 2008). The results are of particular interest for tourism planning institutions (tourism associations and public administration) but are also relevant for individual tourism businesses. The same holds true for index-based vulnerability assessments, which are especially useful for comparing the vulnerability between regions at different spatial scales[3].

Weather- or climate-driven demand analyses comprise services relevant for the daily operational business as well as long-term strategic planning. WEDDA® (www.wedda.at) represents an example of this kind of CS. Statistical models are used to determine the weather sensitivity of tourism demand (e.g. overnight stays, visitor numbers, turnover, or any other economic indicator of interest). Based on these demand models and estimated weather sensitivities, short-term demand forecasts or long-term changes in tourism demand are determined using weather forecasts and climate projections, respectively. Depending on the input data, this service can be provided for tourism businesses and organizations at different spatial scales.

Climate proofing of investments relates to services that appraise investments taking climate change impacts (supply and demand) into account. Different methodological approaches (cost-benefit analysis, annuity method, etc.) are applied, depending on the use case (for an example see Section 3.2.2, and also Damm et al., 2014).

Macroeconomic analyses of climate change impacts on tourism could be relevant information for tourism organizations (tourism associations and public administration) at regional and national level, serving for instance as additional input in the development of tourism strategies (cf. Köberl et al., 2015).

Assessments of environmental conditions, i.e. the loss of natural attractions, water availability, and the risk of natural hazards, are relevant for the tourism sector as well, as they could affect the appeal of tourism destinations and safety for tourists and recreationists. However, the implications for tourism are often not well known. Applications relate to e.g. glacier retreat, permafrost degradation and implications for mountain tourism and maintenance of hiking paths and cabins, coastal erosion and implications for beach tourism, climate change impacts on flora and fauna, and cultural heritage, etc. So far, these services have mostly been provided as outcomes of funded research projects (e.g. Pröbstl and Damm, 2009; Lieb et al., 2010). However, there is potential in providing customized services for the tourism sector, which is for example currently showcased by the H2020 project PUCS. It includes the demonstration of an urban CS for cultural heritage sites that allows for the consideration of expected heat stress, air quality, weather, and pollen load within tourist flow management and provides site specific information about the occurrence and impacts of extreme weather events on cultural heritage on the example of Rome[4].

Further applications relate to forecasts and projections of water levels in rivers which could be relevant information for water sports activities such as rafting, kayaking, canyoning and canoeing.

Services that relate to mitigation and sustainable tourism mostly do not directly use climate data, but build on climate information and climate change impact assessments in a broader sense. These services include guidelines for sustainable tourism (e.g. energy use, sustainable consumption, waste management, mobility) and the analysis of carbon footprints (life cycle assessments – LCA) and ecological footprints.

3.2.2. Current climate services use

Despite the high vulnerability of parts of the tourism sector to climate variability and change, the actual use of CS among tourism stakeholders in Austria is still rather limited according to the interviews conducted. Occasionally, customized CS are used by ski area owners and operators for strategic planning purposes. This may include decisions on (re-)investments and the (partial) dismantling of lift infrastructure (see Box 1 and Box 2), but also the (re-)opening and expansion of ski areas: One of the interviewees talked about a climate expert report on the feasibility and profitability of re-opening a local small-scale ski area. The study, commissioned by surrounding communities of an urban agglomeration had a focus on ski courses for school classes and kindergartens. Overall, interviewed CS providers receive about two requests per year for CS from tourism stakeholders, in particular ski area operators. At the regional level, provincial governments or provincial tourism associations commissioned studies on climate change impacts. Among hoteliers, there seems to be hardly any demand for CS at the moment, according to the conducted interviews.

Weather services[5], by contrast, are used more intensively by tourism stakeholders. They include, for instance, tailored weather, snow and avalanche forecasts, which are used amongst others by tourists, daytrippers, snow managers, ski area operators, hoteliers, and avalanche commissions. Two interviewed tourism businesses – one ski lift operator and the operator of recreational services (outdoor/indoor outdoor swimming pools and wellness centers) – use the short-term demand forecasting tool WEDDA®, for the disposition of staff, merchandise purchase and the planning of food preparations in the restaurant kitchens.

Box 1 and Box 2 show two concrete examples of existing CS in Austria's winter tourism sector. Both refer to services used by ski areas located in the eastern foothills of the Alps. Descriptions on the background, the CS, the implications on the user's decisions and the user's benefits provide an overall picture that, amongst others, allows drawing conclusions on the factors influencing CS uptake.

Box 1

: Assessment of the future snow-reliability of four ski areas in Lower Austria (cf. Abegg and Steiger, 2017).

Background: A destination in Lower Austria received support from the provincial government to increase the competitiveness of its struggling tourism industry. In order to develop a new tourism strategy and climate change adaptation plan, the governmental body required CS assessing the future snow reliability of the four comparably small and low-lying (800–1800 m a. s. l.) ski areas located within the destination.

Climate Service: The CS on the future snow reliability of four ski areas was provided by an Austrian non-academic research institution together with an Austrian university. The service was partly funded by a national research program. The service providers applied a ski season simulation model that accounted for the individual snowmaking capacities of each of the ski resorts. Provided indicators included (i) the change in average season length, (ii) the change in the probability of ski operation during Christmas holidays, and (iii) the required amount of man-made snow to maintain a 100-day season. In addition, snowmaking options under current climatic conditions were analyzed, including the variability in season length given increased snowmaking capacities.

[3] For an example see the web-tool of the MAVERIC project: http://www.iav-mapping.net/U-C-IAV/skiing/

[4] For more information see https://climate-fit.city/stories/cultural-heritage/

[5] Throughout this paper, weather services refer to services focusing on time horizons of up to a month, whereas climate services refer to services dealing with time horizons from a few months up to several decades.

Implications: Based on the information gained from the CS, the governmental body (co–)owning the four ski areas decided to close the lower parts of one ski resort, dismantle the transport facilities and transfer the snowmaking infrastructure to higher-lying parts of the respective resort. In addition, further investments into the snowmaking infrastructure of the ski resort's higher-lying parts were undertaken in the form of an additional reservoir, thus, concentrating on the climatically most promising parts of the ski resort. Besides the measures taken to ensure the maintenance of winter sports tourism, it was decided to operate the lift infrastructure year-round (for mountain-biking, hiking, etc.).

Benefit: The information gained by the CS was used as basis for strategic decision making and was also quoted as one of the motives when communicating the decisions taken to the local stakeholders (i.e. accommodation establishments, citizens, etc.). Compared to publicly available information from generic studies, the customized service provided higher spatial resolution since the user needed the snow reliability assessment to differentiate between different parts of the ski area. In addition, resort specific information on snowmaking capacity and strategy and on financial viability indicators was considered.

Box 2

: Assessment of investment options for a Styrian ski area in the light of climate change.

Background: Due to outdated parts of its snowmaking and lift infrastructure, a small family-oriented ski area (16 ha of skiable terrain, at 860 to 1260 m a. s. l.), located in the eastern Alps in the province of Styria, faced some profound investment decisions: (i) optimizing the existing snowmaking infrastructure with respect to its use of water and electricity, (ii) extending the existing lift infrastructure, and (iii) allowing for all-year-round usage of the lift infrastructure by establishing a mountain-bike park. In order to minimize the risk, the local authority, one of the shareholders of the ski area, sought out professional services on whether investing in snowmaking and/or lift infrastructure was likely to pay off in the light of climate change.

Climate Service: The CS included (i) the assessment of the ski area's importance for the regional economy, (ii) the assessment of the ski area's risks towards climate change, (iii) the analysis of opportunities and challenges associated with the establishment of a mountain-bike park, and (iv) an economic feasibility study of the different investment options, including the outcomes of (i) to (iii). Similar to the example in Box 1, climate change risks were analyzed by means of a ski season simulation model accounting for the ski area's specific snowmaking capacities and extension plans. Using data on current skier days and sales, changes in ski season length were translated into monetary terms and incorporated into the economic feasibility study of the investment options.

Implications: Amongst others, the study concluded that – with the planned optimization investments in snowmaking – operating the ski area at least every second Christmas holiday season and maintaining at least 95 operational days per average season were most likely possible until the 2050 s. Based on the outcomes, the owners decided to invest in the optimization of the existing snowmaking infrastructure. In addition, the report's short version was enclosed to an application for public subsidies at the provincial government of Styria, which supports small- and medium-sized ski resorts in quality-improving investments through a special funding scheme.

Benefit: For the mayor of the municipality it was important to have a neutral and objective decision basis for the local council whether to further invest in the ski area. Moreover, with the short version of the report attached, the public subsidies applied for at the provincial government were granted (previous requests had been rejected).

3.3. User needs

Addressing actual needs of tourism stakeholders represents one of the preconditions for a widespread uptake of CS in the tourism sector. The following user needs are revealed from the interactive explorations with tourism stakeholders and CS providers:

Applicability: Tourism stakeholders articulated a need for very region-specific and local information, and information relevant for their business planning. Existing nation-wide studies on climate change impacts on the tourism usually do not account for the specificities of the respective microclimates, not to mention existing local strategies or adaptive capacities (e.g. a ski resort's snowmaking infrastructure and snowmaking strategy) – and hence their suitability as decision support for local strategic planning is limited.

Ease of use: Climate services need to be easily understandable and compact. Most stakeholders indicated that extensive reports are not required. "*Tourism businesses do not have the time to deal with theory (literature)*", as commented by the Chamber of Commerce. Consulting is considered important, i.e. guidance is needed on how to interpret scientific results, what they mean for a particular tourism region and how to prepare for and adapt to a changing climate.

Fast service delivery: Practitioners require project results and consultancy services to be delivered within a short time period (a couple of weeks/months). This often contradicts the practices and procedures common within the scientific community, of which most of the current CS providers are part.

Short-term services: Tourism stakeholders generally showed higher interest in short-term weather services. They emphasized the need of more accurate weather forecasts as the inaccuracy of weather forecasts bears the potential of causing high damages to the tourism industry. Seasonal forecasting products (e.g. seasonal forecasts on meteorological conditions relevant for snowmaking; seasonal forecasts on skiing equipment sales) are perceived as potentially useful as well; however, skepticism towards the reliability of seasonal forecasting and the potentials for improvements is high. Sufficient forecasting accuracy thus represents an important factor for service uptake and a requirement for its use in operational decision making.

Strategic planning: With respect to climate change adaptation oriented services, ski lift operators (already using CS) requested a more comprehensive mapping and consideration of snowmaking infrastructure within snowpack and ski season simulation models (including the capacity of snow cannons and lances, the water availability, the pumps' delivery rates, and the pipework between reservoirs and cannons), improved long-term projections on foehn events[6], and information on the number of consecutive extreme seasons to be expected in future.

An interviewed public administrator stated the need for advice on adaptation strategies and investments planning (e.g. cycling infrastructure). Tourism associations wish to have detailed information for developing climate-proof tourism strategies. Currently, several Austrian

[6] A foehn (föhn) is a type of dry, warm, down-slope wind that occurs on the downwind side of a mountain range.

provinces as well as the Republic itself have tourism strategies that, at the very least, recognize climate change, but barely go into details with respect to adaptation strategies. Several interview partners from provincial tourism associations reported, though, that climate change will be or has to be addressed in the next tourism strategies more comprehensively.

Research needs: Weather and climate data on their own do not provide a sufficient decision basis for stakeholders, as weather and climate are just one of many factors influencing tourism demand. Stakeholders emphasize the need for an integrated assessment, including general market trends, demographic changes, and changes in travel behavior, but also in relation to climate (change). Information is needed on how tourists react to changing climatic conditions. An integrated assessment addresses related sectors as well (e.g. transport, agriculture). Furthermore, more information on the climate change impacts on summer tourism and shoulder season tourism is required.

3.4. Barriers to CS provision and use

There are several obstacles to an increased uptake or provision of CS in the tourism sector:

Awareness: Stakeholders' risk perception and their current level of suffering rank among the most important factors influencing CS uptake. If potential users are not aware of their climate risks, they do not see a need for CS. Service users in Box 1 and Box 2 each showed a high awareness of the risks faced due to climate variability and change before CS uptake. A great portion of decision makers in the ski industry is, however, not aware of the risks that climate variability and change is posing on their businesses (cf. Trawöger, 2014). The providers of the service described in Box 1, for instance, have often been confronted with the denial of climate change by ski lift operators, who, in this way, justify development plans and investments. A representative of a tourism association stated: "*Climate change is not taken seriously (in the tourism sector). People think they cannot do anything against it. […] Weather/Climate is what it is; nobody wants to put effort into it.*" However, the younger generation of tourism service providers tends to be more risk aware.

Another aspect of awareness relates to the **lack of knowledge of existing services**. Tourism stakeholders indicated not knowing where to find reliable climate information and they are often not aware of the benefits and added value of using CS.

Priorities & capacity: Further reasons for the non-use of CS are the lack of financial pressure and capacities. If the degree of suffering is not high enough, business managers choose other priorities over looking into climate issues. Climate risks are only one among plenty of challenges the tourism industry has to deal with. Addressing climate risks is a complex issue that requires resources outside of one's daily business, e.g. to provide business/region-specific data for CS development and later on to use or interpret the results. Besides, the inherent short-term orientation in business planning and operations of the tourism sector limits the interest in long-term and adaptation oriented CS. Higher interest is, by contrast, shown in weather services and seasonal products.

Especially for small businesses, costs are also a crucial factor for service uptake. The relative importance of the services' costs, however, decreases with the company size of the service user.

Applicability: The need for spatially detailed information was articulated. In order to be practically useful for decision making, climate projections on the resort level are needed, which may require further downscaling of outcomes from regional climate models. As mentioned by Brasseur and Gallardo (2016), regional climate models may, however, not be able to provide more reliable information than global models as they inherit the global models' uncertainties in the atmospheric circulation. Nevertheless, more local (non-climate-related) and customer-specific information can be considered in tailored services. However, there is an insufficient supply of tailored services as research institutions – who provide the services alongside their research and teaching activities – are currently dominating the provider side of the CS market. Hence, little emphasis is put on product development and design, sales and marketing as well as consulting activities. As Abegg and Steiger (2017, p. 64) stated, there is "*[…] a low willingness or ability of academics to […] translate scientific results to the stakeholders and to tailor complicated, complex and detailed results to the interests and needs of decision makers*". This is consistent with the responses of the interviewed tourism stakeholders who mentioned lacking user-friendliness as another barrier to the use of CS.

Lack of trust: Stakeholders in the tourism industry are partly skeptical about research studies on climate change due to the impression of conflicting messages as well as the difficulties in directly drawing conclusions or recommendations meeting their needs. Some stakeholders also see the uncertainty of climate scenarios as a reason for not using climate services. In addition, generic studies about climate change impacts on skiing tourism partly caused dissatisfaction among ski lift operators in the past, as (too) generalized statements on their vulnerability presented a threat to their creditworthiness.

Trade-offs between economy and ecology: Tourism stakeholders, in particular ski resorts, are reluctant to look into climate issues because (winter) tourism has a legitimation issue with regards to environmental damage it may cause. Public discourse is increasingly calling the environmental impacts of ski slopes and lifts into question.

Barriers to CS provision: In countries where the use of meteorological data for commercial purposes is associated with high acquisition costs (e.g. Austria), the provision and uptake of CS may be hindered. It represents a barrier, particularly in the product development phase, where for testing purposes the data requirements often comprise several parameters, various locations, etc.

4. Discussion and conclusions

In this study we identified the constraints and enablers shaping climate services (CS) uptake in the Austrian tourism sector. The paper focuses on mountain summer and winter tourism, and is subject to the usual limitations of qualitative research. Risk awareness and current weather and climate vulnerability affect the willingness of stakeholders to participate in a survey on this topic and thus the representativity of the study results may be affected in this regard. Direct transferability of the results to other destinations and tourism types is limited. However, there are similarities in the identified obstacles and user needs across different regions and sectors (cf. Bater, 2018). Overall, it seems that there is no major market demand for climate services in the tourism sector at the moment. The results from the above mentioned parallel Finnish tourism case study, support these findings (Damm et al., 2018). The perceived barriers to use CS and identified user needs are quite similar in both countries. Finally, the following conclusions and recommendations can be drawn:

Awareness-raising of climate risks is still one of the main drivers for CS uptake. If potential users are not aware of their climate risks and familiar and CS-related benefits, they do not see a need for CS. Even if there is climate risk awareness, lack of long-term risk management often still hinders the use of CS. Short business decision cycles – maximum five years ahead – seem to be quite common. Thus, tourism actors showed, if at all, higher interest in weather services and seasonal products than CS. However, dealing with weather variability and using weather services may also increase to some extent the interest in CS and thus could be used as potential leverage for CS uptake. The use of CS in the tourism sector, however, may be more of a concern for tourism service providers with high investment needs in infrastructure and high vulnerability (e.g. ski lift operators). If the financial pressure and current level of suffering are not high enough, though, tourism service providers choose other priorities over climate issues.

Climate services and their benefits need to be better demonstrated and communicated. Tourism businesses are often unaware of existing CS, CS providers, and where to find reliable information. The communication channels of interest groups (e.g. provincial tourism associations, association of cable cars) could be used to present the latest findings of tourism-related climate research and to demonstrate the added value of CS. This could also be shaped as communities of users, as tourism professionals may accept recommendations from their peers more willingly than from experts outside the tourism sector.

In addition, a platform to present providers and their CS would improve visibility. Therefore, existing platforms presenting climate researchers and their expertise (e.g. *kompetenzlandkarte.ccca.at [AT], climate-knowledge-hub.org* [EU]) could be expanded so that climate researchers and CS providers have the opportunity to promote their CS by including a short description and examples of their services.

In general, the willingness to pay for CS seems to be rather low. Nevertheless, those tourism regions and businesses that have already suffered from climate variability and extremes are more interested in climate issues and are more willing to pay for customized climate services and assessments of future impacts and adaptation options. Overall, better communication and demonstration of the benefits of CS use – e.g. through best practice examples and experience reports from users – could increase the willingness to pay for tailored services as well.

Furthermore, these tailored and more advanced CS will get more affordable (a) as part of a package with other, already used, strategic intelligence besides climate (e.g. market research, demographic trends, etc.) and (b) when purchased in a bundle by several users that share at least some common interests in CS – be it on a local or regional scale (like a tourism region) or from the same kind of business perspective (like a group of hoteliers or an association of ski lift operators).

It does not seem very likely that systematic support from the public sector will arise, e.g. in terms of subsidies to be spent on CS. However, public policy can play a crucial role by supporting initiatives that (intend to) use CS for area-specific climate risk assessments and by stimulating other areas to follow up on pilot projects that have already been proven to be promising elsewhere. So, it would help if actors got a sense of how much money they could save by using CS or how much earnings they might forego when not using CS, and, if it became common practice, to require a sort of climate risk assessment for subsidies and other permissions to engage in tourism.

Concerning market development and service innovation, we have emphasized the importance of user inclusion, as has the EU Roadmap for CS (European Commission, DG for Research and Innovation, 2015). Users can no longer be seen as external factors only, since the entire idea of service has shifted from product provision to service provision (cf. Bruhn and Hadwich, 2016; Hamaker et al., 2017; Stegmaier and Visscher, 2017). There are also some very practical reasons for user inclusion: at an early stage of the value chain, users may help to better define what is needed; and at a later stage, user participation would allow for a far higher level of quality management than mere user polls. In between, smart client involvement is imperative in the light of contemporary service understanding that centers around the notion of an active and embedded user. In doing so, in close collaboration with providers and purveyors, users could also learn to better express what they need from a climate service, while providers and purveyors could improve how they evaluate and respond to market developments. However, co-design requires expertise and sufficient resources. Successful co-operation between providers and users is a matter of trust and communication and requires a shared understanding of terms and concepts.

In further research, we could investigate what it means to look at a service market in tourism. This would allow us to see the findings in the context of interacting in a market: e.g. which market models serve the purpose of CS for tourism, if the stakeholder perceptions are taken seriously; which business models could be derived from such market models; or how joint service production would have to look like with different market and business models. Would, for instance, standardized pricing mechanisms apply, or, due to rather untenable price-quantity relations, prices be set on a case by case basis, or bilateral contracting (cf. Karmarkar and Pitbladdo, 1995). Perhaps we have to assume that market transactions in services are more or differently complex than in non-service markets. So, what would be the properties of such a service market transaction, and how could it be translated into a business model for e.g. intermediaries, meteorological institutes, or even user associations (e.g. a cable car association) commissioning CS for their members?

To conclude, there is still room for innovative services that are able to translate and tailor complicated and complex climate information to the needs of decision makers. The market could benefit from a more diversified set of providers and more intermediaries bridging the gap between research and applicability. Spatially detailed information, guidance on how to interpret the results, what they mean for a particular tourism region, and how to prepare for and adapt to a changing climate are needed. Funding schemes explicitly addressing adaptation and mitigation and the development of prototypes in the tourism sector as well as open public data policy could help to overcome financial barriers.

Declaration of interest

We would like to declare that the authors' organizations (Joanneum Research, Acclimatise, Finnish Meteorological Institute) offer climate services that are partly discussed in this publication. Deep knowledge about these products has been an essential asset to the analysis.

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