REPORT ON THE RESULTS OF EXPLORATIONS OF CS MARKET DEVELOPMENT OPTIONS FOR THE TOURISM SECTOR

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List of Abbreviations

CIC	Climate Inclusive Consulting
CS	Climate Services
CC	Climate Change
CCCA	Climate Change Centre Austria
CSR	Corporate Social Responsibility
CTA	Constructive Technology Assessment
NMS	National Meteorological Service

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NON-TECHNICAL SUMMARY

Given the societal and economic challenges generated by climate change, it is 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 unaddressed gaps existing between supply and demand.

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

The current use of climate services in the tourism sector is rather limited. On the other hand, the use of weather services is quite common. The main barriers to the use of CS in the tourism sector include wide-spread low levels of risk awareness and risk denial, 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 both applicability of the provided information as well as integration with other services or consultancy, and distrust in climate services due to conflicting messages in the media and the uncertainty of climate scenarios hamper their use.

Tourism stakeholders' needs demand high spatial resolution, i.e. climate change impact assessments and adaptation strategies at local/regional level, presented in a simple and compact way. Consultancy services are considered highly relevant. Since climate is only one factor influencing future development, an integrated assessment including general market trends, demographic changes, changes in travel behaviour etc. is needed. Overall, tourism stakeholders showed higher interest in short-term and seasonal services. However, the use of weather services that help manage current weather risks and climate variability may increase – over time – the interest in climate services to some extent and thus could be used as potential leverage for CS uptake.

Recommendations for an enhanced take-up of climate services include a better communication of current knowledge as well as a better demonstration of tailored CS and communication of their added value. In this regard umbrella organizations could play a significant role as they could act as knowledge brokers to raise the awareness for CS among their members and to coordinate options for joint CS acquisition.

Furthermore, the market would benefit from a more diversified set of providers as CS are currently mainly provided by research institutions alongside to their research and teaching activities. Hence, too little emphasis is put on product development and design, sales and marketing as well as consulting activities. There is room for actors in establishing a better link between science and potential end-users. This may also include enticing tourism consultants to act as purveyors of climate information.

1 INTRODUCTION

The European Commission has taken several actions in its current research programme Horizon 2020 (H2020) in order to support further product development and effective widespread uptake of climate services, as a means to boost mitigation of and adaptation to climate change as well as capabilities to cope with climate variability. Essentially these actions follow from the logic to implement the European Research and Innovation Roadmap for Climate Services (cf. European Commission 2015).

EU-MACS and its sister project MARCO deal with the analysis of the climate services market. In addition, demonstration calls were launched on the added value of climate services for supposedly high value-added sectors with hitherto little uptake of climate services (SC5-01-2016-2017), while other actions focus more on networking activities interlinking to better connect relevant players (e.g. the ERA-NET for Climate Services (SC5-02-2015) and the project funded under the Coordination and Support Action (SC5-05b-2015) called Climateurope.

An extremely important sub-programme in H2020 is the COPERNICUS Climate Change Service (C3S) programme, which aims to generate a very comprehensive coherent and quality assured climate data set meant to support mitigation and adaptation planning, implementation and monitoring. In due course also coping capabilities of (current) climate variability are addressed.

In this framing, EU-MACS – European Market for Climate Services – analyses market structures and drivers, obstacles and opportunities from scientific, technical, legal, ethical, governance and socioeconomic vantage points. The analysis is grounded in economic and social science embedded innovation theories on how service markets with public and private features can develop, and how innovations may succeed.

What is a Climate Service?

EU-MACS employs the definition of climate services as formulated in the EC's Climate Services Roadmap: "…., we attribute to the term a broad meaning, which covers 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. As such, these services include data, information and knowledge that support adaptation, mitigation and disaster risk management (DRM)."

Work package 3 of EU-MACS aims at exploring the market for climate services in the tourism sector. By means of interviews, online surveys and workshops with tourism stakeholders we investigate the main barriers hampering actual market uptake, identify the user needs and assess CS options and market development needs.

The report is structured as follows: In section 2 some background information on the tourism sector's characteristics, as well as the relations between tourism, weather and climate is provided. Furthermore, we review the current CS market in the tourism sector and CS options and summarize previous CS

(market) research projects related to tourism. Section 3 describes the methodological approach of the interactive CS explorations in the two case studies Austria and Finland. The empirical results are shown in section 4 (Austria) and section 5 (Finland). Overall conclusions and recommendations are presented in section 6.

2 BACKGROUND

2.1 Characteristics of the tourism sector

The tourism sector shows some characteristics that clearly differ from other economic sectors. Strictly speaking, there is no such thing as a "tourism industry". The scope and structure of this "industry" is rather directly determined through the products and services consumed by tourists. Hence, a number of different economic sectors contribute to the "tourism industry", including accommodation, food and beverage services, transportation, recreation and entertainment, travel agencies, retail etc.

Tourism is a service activity and is thus *intangible*. Hence, inbound and outbound tourism are invisible exports and imports respectively. Nevertheless, the provision of tourism services often requires investments in infrastructure (which is tangible).

Another characteristic of tourism services is *perishability*. Many typical products and services of the tourism and travel industry cannot be stored for future sales if not consumed in the moment of their "production". This applies for instance to hotel rooms, cable car seats and train seats, where capacity unused within a particular period cannot be sold at a later time. This is why tourism and travel businesses tend to overbook available rooms and seats and increasing price differentiation and yield management is applied. Furthermore, many tourism products and services are quite *inflexible* with respect to spontaneous fluctuations in demand, as capacities cannot be changed quickly enough. Thus, there is a need for balancing the trade-off between unused capacities and rejected customers due to missing capacities (Kaiser 2012; Wall and Mathieson 2006; Vanhove 2018).

Products and services of the tourism industry can hardly be completely standardized since their quality as perceived by the customers is strongly affected by various unswayable aspects, including the actual weather conditions or other customers (Kaiser 2012).

In many tourism-related businesses (e.g. accommodation establishments, ski areas) a large portion of the capital is locked up in assets. These assets are often attached to one locality. Hence, these kinds of tourism businesses highly depend on the attractiveness of their surroundings, including the climatic characteristics (Kaiser 2012).

Tourism is *prone to local and international competition,* not only because many products and services are easy to copy (Kaiser 2012). There is competition between different tourism destinations offering the same tourism activity, but also between tourism destinations offering different kinds of tourism activities (beach tourism, ski tourism, city tourism etc.).

Seasonality is another important characteristic of tourism. Annually, there are weeks and months with a great demand and others with a low demand. This uneven distribution is different from destination to destination. The main factor responsible for seasonality is climate, but other factors like school holidays and annual paid leave in businesses play a role as well (Vanhove 2018).

Interdependence of tourism products: An individual tourist buys a whole set of products supplied by different firms – the attractions have no economic value without the necessary accommodation, but the latter cannot function properly without the supporting factors and resources – infrastructure, accessibility, facilitating resources and hospitality. A destination is a cluster of activities, and a bad performance by one sub-sector influences the profitability of the other sectors of the cluster. Different suppliers always benefit from combining their respective efforts (Vanhove 2018).

Especially services in the core businesses of tourism (accommodation, gastronomy) are characterized by a high *labour-intensity* as well as *high fixed and relatively low variable costs* (Keller 2012).

Tourism is a strongly *demand-driven* and *dynamic* sector. As preferences and attitudes of tourists are subject to constant changes, suppliers of tourist products and services are used to the necessity to adapt. Significant up- and downswings in tourism demand, which are often subject to unpredictable external influences (e.g. terrorist attacks, political unrest, energy shortages, changes in currency exchange rates, extreme climatic events), have the potential to preempt perceived benefits of long-term planning (Wall and Mathieson 2006).

The tourism sector's specific characteristics thus may influence the requirements of climate services. Moreover, the need for climate services may differ between the different types of tourism stakeholders, such as tourism businesses, tourism associations, tourism related interest groups, and public administration. Figure 1 gives an overview of the identified stakeholder groups at different administrative levels on the example of Austria, which provided the basis for stakeholder selection (see section 3.1.1).

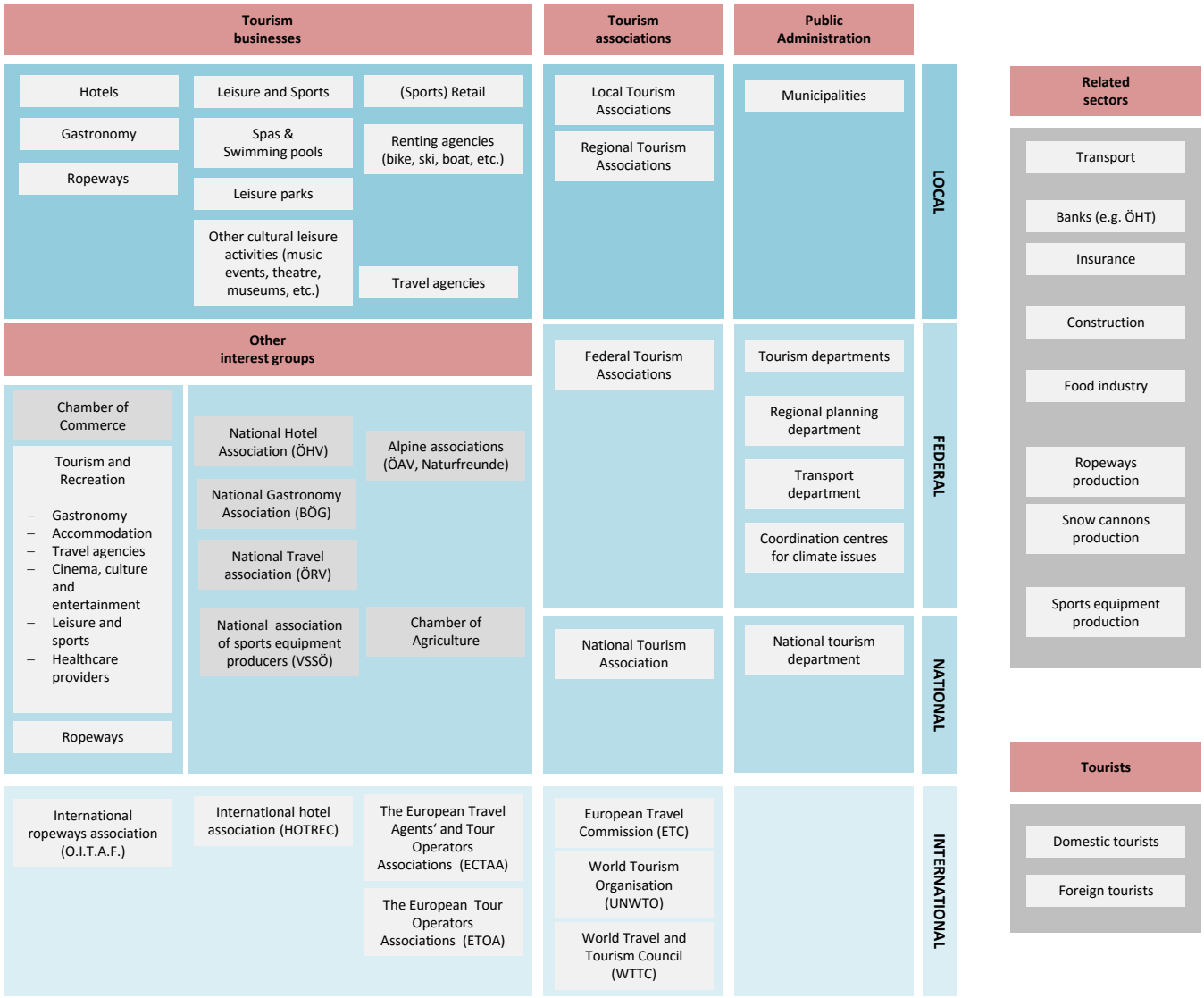

FIGURE 1: MAPPING OF TOURISM STAKEHOLDERS ON THE AUSTRIAN EXAMPLE (BASED ON KOEBERL ET AL. 2018)

2.2 Tourism, weather and climate

Tourism is one of the most weather- and climate-sensitive sectors. All tourism destinations are climate-sensitive to a degree in that they are influenced by natural seasonality and demand, which are defining characteristics of tourism worldwide. Tourism destinations are affected either positively or negatively by inter-annual climate variability. This climate variability may bring heat waves, unseasonable cold, drought, storms, and heavy rain, which can affect not only tourist comfort and safety (and thereby satisfaction), but also the products that attract tourists (e.g. snow cover, coral reefs) or deter them (e.g. infectious disease, wildfires, tropical cyclones, heat waves). Climate variability also influences various facets of tourism operations (e.g. water supply and quality, heating-cooling costs, snowmaking requirements). Further, weather and climate have a broad significance to tourist decision-making and the travel experience, significantly influencing travel patterns (Scott *et al*. 2011, p.112).

Thus, climate change impacts tourism in many ways. Becken (2010) categorizes the impacts in three ways: (i) as a result of gradual changes such as temperature or sea level rise; (ii) due to increased numbers of extreme events such as high winds, and (iii) as a result of wider environmental changes that alter the resource base of tourism, for example limited water availability or changing ecosystems. Gössling et al. (2012) identify four major types of climate change impacts on tourism demand: (i) direct impacts of a changed climate (e.g. less natural snow fall), (ii) indirect impacts of environmental change (e.g. loss of natural attractions), (iii) mitigation policy and tourist mobility (e.g. the use of tax instruments which may lead to an increase in the costs of travel), and (iv) societal change related to reduced economic growth, consumer cultures and social-political stability. Further, CC impacts on tourism attractions and changes in seasons impact the destination competitiveness. Changes in weather and climate conditions such as prolonged seasons may, however, also open up new areas and opportunities for tourism (Nalau *et al*. 2017).

Climate is, however, only one of several factors influencing tourism (e.g. economic growth/recession, transport access/cost, political stability/security, technological change, demographic change, currency exchange rates, border agreements) (cf. Scott *et al*. 2011, Figure 1).

2.3 Climate services in the tourism sector

Figure 2 provides a conceptual framework of climate information and service suppliers and end-users in the tourism sector, based on Scott et al. (2011). National meteorological services (NMS) and private weather services are the primary sources of weather and climate data, which is either directly delivered to tourism end-users or used by universities, research institutes or consultancies to provide specialized climate services for the tourism sector. Tourism operators and destinations are users of weather and climate information and services, but also act as service providers for tourists.

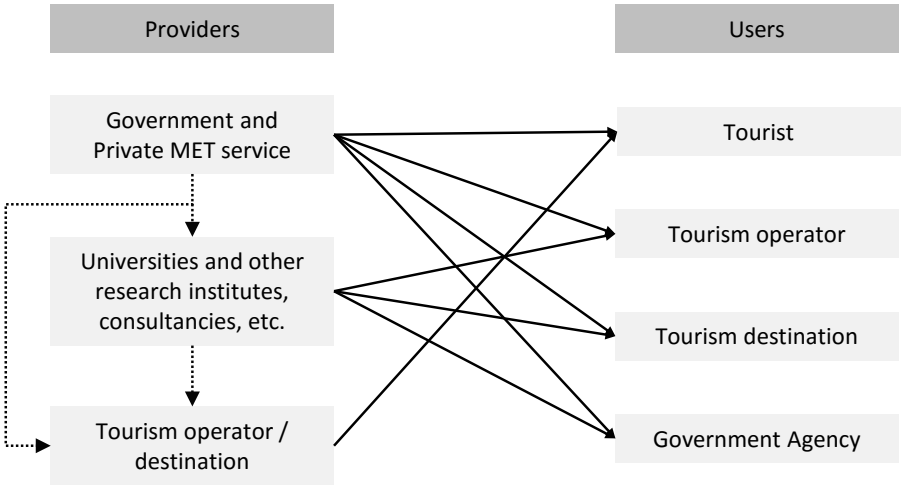

FIGURE 2: CLIMATE INFORMATION AND SERVICE PROVIDERS AND USERS IN THE TOURISM SECTOR (SCOTT ET AL. 2011, MODIFIED)

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. Table 1gives an overview of potential uses of weather and climate information within the tourism sector, based on Scott et al. (2011). The field of application for tourism operators and planners range from site location analysis and 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.

TABLE 1: POTENTIAL USES OF WEATHER AND CLIMATE INFORMATION BY TOURISM OPERATORS, TRAVEL PLANNERS AND TOURISTS (BASED ON SCOTT ET AL. 2011)

	Historical climate/ Observational	**Weather** Nowcasting, short-term (hours, days)	**Weather/ Future climate** (Seasonal forecasts, climate changes projections) Weeks, seasons, years	**Future climate** (Climate change projections) years, 100 years
Tourism operators, travel planners	Site location, facility design, architecture, insurance needs, building and land-use regulations	Disaster risk management, maintenance, daily guest information, building energy management Cruise ship routing, outdoor activities planning, operational decision making - maintenance scheduling, staff scheduling, conditions forecasting, etc.	Investment decisions, revenue forecasting, seasonal occupancy forecasts, delivery rate setting, insurance needs (premium, deductible), climate image branding and marketing development, job creation, operations, developing climate competitive advantage, etc.	Site location, facility design, federal policy development, mitigation strategy design, building code setting, regional policy and planning, new facility capacity plans, development master planning, predicting/catering to changing client demands, emergency preparedness, etc.
Tourists	Destination choice, timing of travel, activity planning, insurance needs	Timing of travel (last minute holiday), On-site behavior: activity planning/ choice, travel routing	Destination choice, timing of travel	

Figure 3 shows a thematic mapping of (potential) climate services in the tourism sector. The mapping is based on background research and the conducted interviews with tourism stakeholders and CS providers (see section 3.1.1). Depending on the use case, different spatial scales and formats are applied. The color coding indicates which data or disciplines the service is based on, e.g. bright green boxes represent CS which are only natural science based (climatology and hydrology) while dark green boxes are CS that combine climate data with socio-economic data.

Tailored 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 example concerning the Schladming night race – an annual ski race – was mentioned by an interviewed CS provider, see section 4.2.1). Climate statistics based on observational data serves as information for tourists concerning timing of travelling and destination choice. For the planning of new tourism facilities and attractions, a destination's climatic suitability could be evaluated on the basis of climate scenario data. Observed climate data can 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 could be relevant for individual tourism businesses or tourism destinations.

Historical climate data is also the foundation for the emerging application of weather derivatives and index insurance products to reduce weather risk 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, which have begun to be offered e.g. for destinations in the south of France by travel agents in France 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 (Leisure Park) 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 to receive projections of snow reliability and snowmaking conditions for their particular ski region. The benefits of these customized services include the consideration of the ski resort's actual or planned snowmaking capacity within the snow simulations and the ski-resort-specific calibration of the snow models using the nearest measurement station data. Two particular services are described in more detail in the MARCO Deliverable 5.10 (Case Study 9 Report – Tourism, Köberl *et al.* 2018).

In the short-run, it is common to use weather forecast data for the operational snowmaking management (highly resolved forecasts on a commercial basis, provided by the NMS 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 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.

[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]

Assessments of consumer behavior and behavioral adaptation are mainly results 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 the long-term strategic planning. These services are provided e.g. by JOANNEUM RESEARCH under the brand WEDDA®. 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-forecast data 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. One example refers to a ski resort's required investments in snowmaking infrastructure, based on snow simulations and determined needs for snowmaking as well as respective technological capacities (snow cannons, water reservoirs etc.). These investment assessments take expected revenue changes into account, resulting from altered skiing demand due to changing snow conditions and ski operating days, as well as changes in snowmaking operating costs. Different methodological approaches (cost-benefit analysis, annuity method, etc.) are applied, depending on the use case (cf. 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 (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 attractiveness 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, CC impacts on flora and fauna, CC impacts on cultural heritage, etc. These services have mostly been provided so far as outcome of funded research projects (e.g. Pröbstl and Damm 2009; Lieb et al. 2010). However, there is potential in providing customized services for tourism regions. In the H2020 project PUCS/Climate-fit.city a climate service demonstration will be provided that includes an improved tourist flow management system as well as 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.

[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/

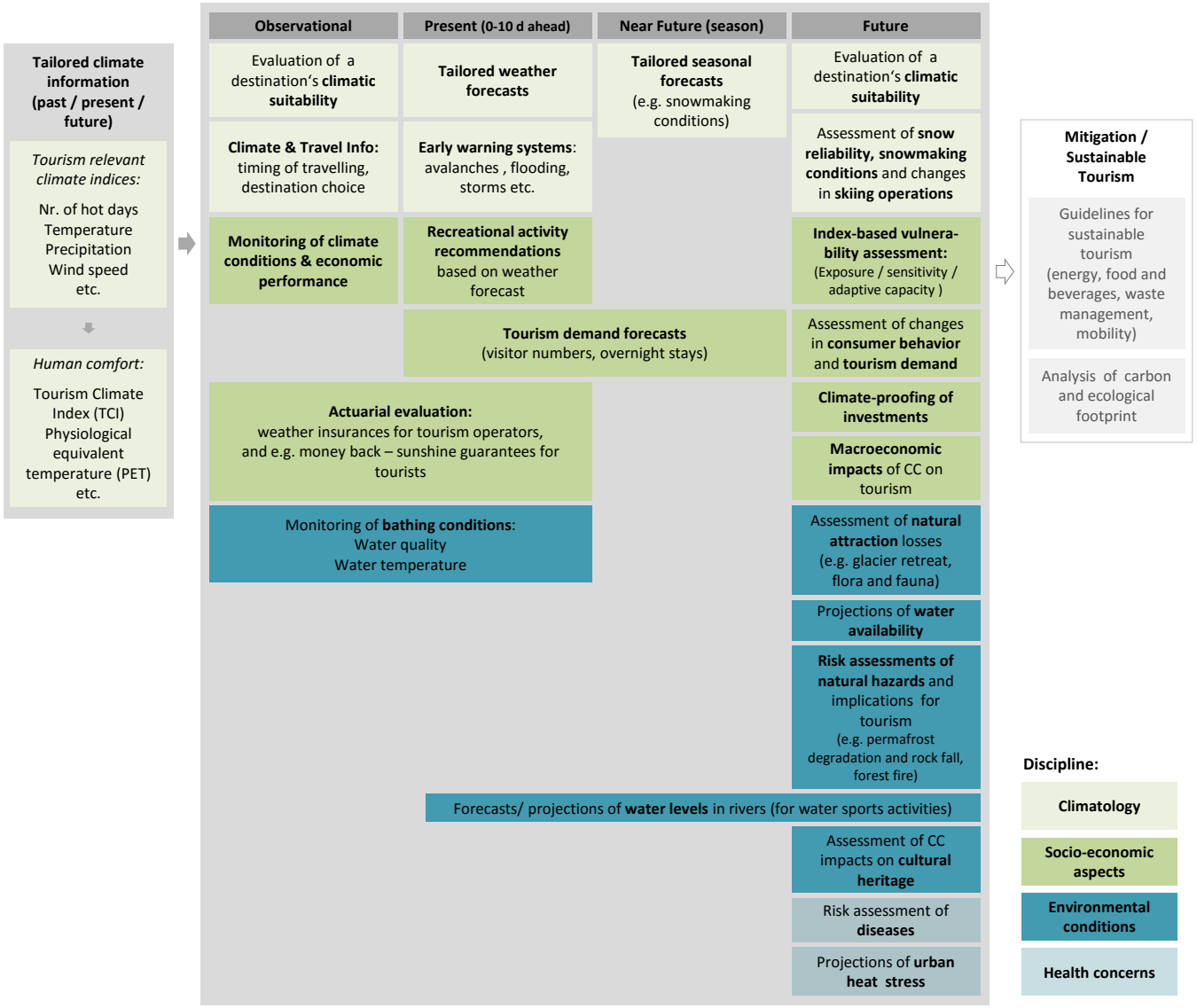

FIGURE 3: A SET OF THEMES FOR PROVIDING WEATHER AND CLIMATE SERVICES IN THE TOURISM SECTOR

Services that are related 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.

One of the targets of the UN Sustainable Development Goals (SDG) is to "devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products" by 2030. In this context, the SDGs could be seen as a policy driver for CS as well[5]. Sustainable tourism has already gained importance in the recent past, in particular in the hospitality industry. "Alpine Pearls"[6] is a good

[5] Other framework conditions for the use of CS in the tourism sector are discussed in MARCO Deliverable D5.10 (Köberl *et al.* 2018).
[6] https://www.alpine-pearls.com/en/

example of tourism regions which explicitly focus on sustainable tourism. Climate protection is seen as a business opportunity and hence included in their marketing strategies.

2.4 European projects addressing CS in the tourism sector – a review

CLIM-RUN (2011-2014, EU FP7):

The CLIM-RUN project aimed at developing a protocol for applying new methodologies and improved modeling and downscaling tools for the provision of adequate climate information at regional to local scale that is relevant to and usable for different stakeholders in the Mediterranean region. The CLIM-RUN case studies focused on tourism, energy and wild fires. Four tourism case studies were considered: (i) the Savoy region in the French Alps, focusing on summer tourism conditions; (ii) Tunisia, focusing on beach tourism with some diversification aspects (desert tourism, golf, etc.); (iii) Croatia, also a seaside tourism destination, with a clear focus on diversification (beach tourism yachting, winter and snow tourism, cultural tourism); and (iv) Cyprus, also a seaside tourism destination with some rural locations in the hinterland. Interviews and workshops were conducted to identify and respond to the stakeholders' needs about past and future climate information and services. As a result, product information sheets (1-2 pages) have been developed, concerning e.g. bathing water in mountain lakes, evolution of temperatures in high mountain areas, spring conditions in Savoy, risk posed by extremes, the tourism climate comfort index in Tunisia, or sea surface temperature in coastal regions. The sheets include information on target groups, relevance to the case-study requirements, methods, product examples and information on how to make the product useable (Dubois *et al.* 2013).

Current use of CS in the 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 services. The authors conclude that the questionnaire might have been too generic and had assumed that the users know their needs a priori. Furthermore, the project focused on climate change variables, while stakeholders requested some information on weather and climate impacts (e.g. they are primarily interested in snow cover rather than in snow fall). Generally, stakeholders referred to weather forecasts or seasonal forecasts and concentrated on small geographical areas demanding high resolution products, which are often not realizable.

EUPORIAS (2012-2017, EU-FP7):

EUPORIAS aimed at developing prototypes of climate services – in close collaboration with European stakeholders. The prototypes provide working examples of 'end-to-end' climate-to-impacts-to-decision-making services operating on the Seasonal and Decadal (S2D) time scales. In addition to five prototypes, six case studies have been conducted in EUPORIAS, in which the potential for climate services has been analyzed. One tourism related case study was PROSNOW, which endeavors to deliver a seamless sub-seasonal to seasonal snow prediction system specifically tailored for the ski industry in the Alpine area. This service contributes to a better management of ski resorts and overall better anticipation capabilities of stakeholders at play (Buontempo *et al.* 2016). PROSNOW is further developed in the ongoing H2020 demonstrator project PROSNOW (2017-2020).

PROSNOW (2017-2020, H2020):

The ongoing PROSNOW project aims at building a demonstrator of a decision-making service for snow management in ski resorts, based both on meteorological (several days) and seasonal (several months) forecasts. The tool is intended to provide forecasting information in a form directly applicable by ski area

operators and snow managers (e.g. snow depths / heights), together with precise information on the uncertainties affecting them. A co-design approach is followed in order to ensure optimal tailoring to the needs of the ski industry, with eight pilot ski resorts and various providers of technical solutions supporting snow management being involved in this co-design process. The added value of the demonstrator is planned to be assessed not only for the ski industry but also for additional stakeholders, including local and regional tourism authorities, hydropower managers, and natural hazard forecasters and managers. At the end of the project it is envisaged to transform the demonstrator into a commercial service. Market adoption is expected to be supported by the involved providers of technical solutions who may enlarge their offers with PROSNOW services.

SECTEUR (2016 - 2017, Copernicus C3S):

The SECTEUR project aimed to better understand user requirements of climate information in terms of Essential Climate Variables (ECV) and Climate Impact Indicators (CII) to identify gaps and deliver recommendations on future needs to support better decision-making. The project focused on six areas: agriculture and forestry, coastal areas, health, infrastructure, insurance, and tourism. A questionnaire survey was conducted, with a total of 438 responses and 68 tourism sector specific responses. The survey asked for climate information and indicators currently in use in the tourism sector. The results are shown in Figure 4. The top three most frequently used information/indicators included i) information about alterations to natural ecosystems (e.g. reduction in wetlands) (n=42), water quality (n=42) and changes in winter/summer overnight stays (n=37). The least commonly used information/indicators included the UV index and hedonic values of holidays, which received less than 10 responses (Alexander *et al.* 2016b). 'Impact of climate on marine biodiversity and in particular in coastal areas and on coral reefs' was in particular requested by respondents as additional information desired, which is currently not in use. In a workshop use cases were discussed in detail: snow reliability indicators, Tourism climate index, coastal tourism, and cross-sectoral use cases – forest fires, drought, and transportation.

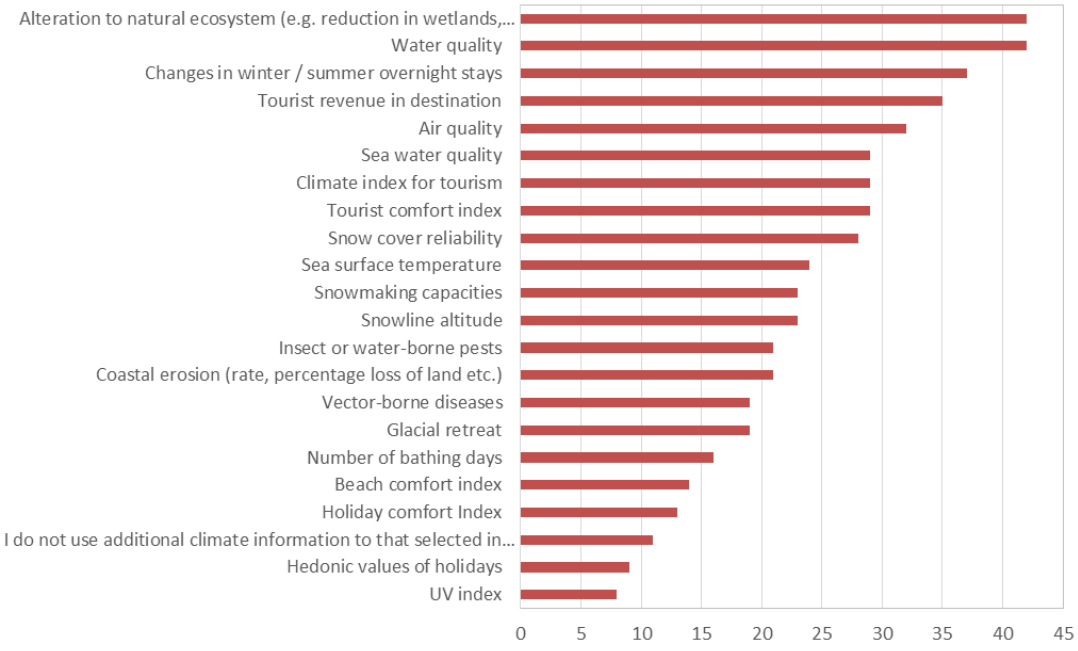

FIGURE 4: NUMBER OF SECTEUR'S RESPONDENTS USING CLIMATE INFORMATION/IMPACT INDICATORS IDENTIFIED WITHIN THE TOURISM THEME (ALEXANDER *ET AL.* 2016B).

3 METHODOLOGY

WP3 focuses on two case studies: Austria and Finland. The methodological approach applied in these two case studies differs somewhat due to difficulties in engaging stakeholders. Figure 5 shows the workflow in both case studies which is described in more detail in the following sections.

In Finland, the workshop planned as the second step was eventually cancelled due to a low number of registered attendees. Instead, an online survey continuing the themes arisen in the interviews was conducted, followed by a final round of interviews.

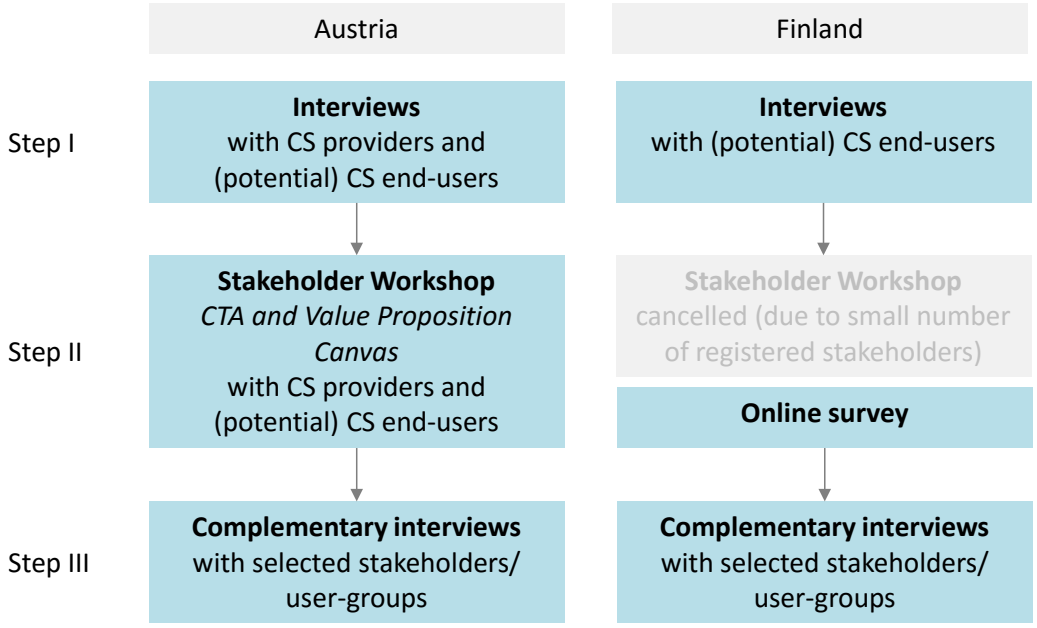

FIGURE 5: WP3 WORKFLOW

3.1 Case study – Austria

3.1.1 Interviews

Semi-structured interviews were conducted with CS providers and (potential) end-users from the tourism industry. The interviews aimed at identifying the current supply and use of CS in tourism, perceived barriers to the use and provision of CS, and (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. The questions about their stakeholder networks aimed at validating the stakeholder mapping. We prepared interview guidelines, which were inspired by questionnaires of Goodess (2013), Göransson and Rummukainen (2014), Manez *et al.* (2013), and Alexander *et al.* (2016). The guidelines are shown in Annex A.

59 tourism stakeholders were contacted, whereof 35 persons responded and 21 agreed to an interview. Table 2 lists the contacted and interviewed stakeholders by type of organization. We selected the

potential interview partners 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 Figure 1. Concerning tourism businesses we regionally focused on the eastern part of Austria, as we expected to have a higher participation rate among the interview partners in the subsequent stakeholder workshop held in Graz.

TABLE 2: CONTACTED AND INTERVIEWED TOURISM STAKEHOLDERS

Tourism stakeholder	contacted	interviewed
National tourism association	1	
Provincial tourism associations (Vienna, Burgenland, Upper Austria, Lower Austria, Styria, Tyrol, Vorarlberg)*	9	7
Regional tourism associations (2 in Styria)	7	2
National public administration – tourism department	1	
Provincial public administration (Burgenland – tourism department)	8	1
Chamber of Commerce (Styria - tourism department)	2	1
National hotels association	1	1
Other interest groups	2	
Hospitality sector (1 marketing manager of a 5* Hotel in Tyrol, 1 hotel manager of hotels in the wine regions in Styria and Lower Austria)	9	2
Ski resorts (4 Styria and 1 Lower Austria)	10	5
Recreational services (Styria - Spas & Swimming pools)	3	1
Sports retail	4	
Sports equipment production	2	1
Banks	1	

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

In addition to tourism stakeholders, we contacted 19 researchers and consultants in the field of climate and tourism; with 11 persons we finally conducted an interview to examine the current supply of CS, perceived barriers to providing and using CS, and perceived user needs. Table 3 lists the contacted and interviewed researchers and consultants by type. Most of the interviewed providers/researchers can also be seen as intermediary users of CS. We selected the potential interview partners based on known literature in this field, personal contacts and internet research.

The interviews were held in German language, transcribed and qualitatively evaluated and summarized. The interview results are presented in section 4.

TABLE 3: CONTACTED AND INTERVIEWED CS PROVIDERS/RESEARCHERS

CS provider/researcher	contacted	interviewed
University or research institute (Hydrology/Snow modelling, Meteorology, Landscape development, recreation and conservation planning, participatory planning processes, Travel behavior, sustainable tourism development)	10	6
National meteorological service (Research coordination)	1	1
Private business (Private weather service, Tourism consultancy)	7	3
Other (National park)	1	1

3.1.2 Workshop

The stakeholder workshop aimed at bringing together the different types of stakeholders from the tourism industry as well as CS providers, allowing an exchange of views on climate services use and provision, obstacles and enablers. The stakeholder workshop in Graz, Austria, consisted of three parts (cf. Stegmaier and Visscher 2017): the first part included an introduction to the project and a presentation and discussion of first findings from the interviews regarding barriers and enablers of CS in stakeholder comparison. The second part was dedicated to Constructive Technology Assessment (CTA). The CTA part of the workshop offered a set of specific viewpoints to consider scenarios of using climate services, while at the same time giving ample space for discussion of aspects stakeholders find important. In the afternoon session – the third part of the workshop – we discussed two typical business cases, one specifically with regards to ski lift operators' views and one regarding the situation and demands of local tourism organisations. Here, the value proposition canvas was applied.

In total, we sent out 40 workshop invitations – to the interviewed (potential) CS users and selected CS providers and to some new contacts. In the end 10 stakeholders participated in the workshop:

TABLE 4: WORKSHOP PARTICIPANTS IN GRAZ (AUSTRIA)

Workshop participants	
Ski resorts (Ropeways) – 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

In the following the CTA and value proposition canvas is explained in more detail.

Constructive Technology Assessment (CTA)

Constructive Technology Assessment (CTA) aims at making innovations benefit from concepts of innovation studies. It is an approach originally developed for the prospective shaping of technology. The main rational of CTA is to get all concerned actors together at an early stage of development (when modifications are still possible) on the basis of sound research about the subject matter and its context, and then "insert" considerations into developmental process that "improve" what is emerging (Kulve and Rip 2011; Rip and Kulve 2008). For the purpose of this project, CTA has been appropriated to contribute to the shaping of services and markets in a series of national, European, and worldwide efforts to promote climate data and climate intelligence in various areas of policy-making and business.

Four scenarios have been developed: the 'maps & apps scenario', the 'expert analysis scenario', 'climate-inclusive consulting scenario', and the 'sharing practices scenario' (see Table 5). The scenarios allow for distinguishing constellations that are typical for contemporary service practice. Besides specific characteristics of 'users' and 'service providers', these scenarios also include more context-sensitive dimensions: (a) technological features of climate service provision and therefore a dedicated appraisal of socio-technical circumstances under which climate services could function for various specific users and providers; they also focus on (b) requirements for value creation and therefore allow for reflection on underlying business models; finally, (c) with the category 'potential tensions', we include attention for further practical, institutional, organisational, or other influences on what counts as and could be used as a climate service in specific contexts. More details on the CTA approach can be found in the EU-MACS deliverable D1.4 (Stegmaier and Visscher 2017).

The four scenarios formed the basis of discussions in the CTA part of the workshop.

TABLE 5: OVERVIEW OF CTA SCENARIO CORE CHARACTERISTICS

	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

The concept of value proposition and business design

The afternoon session of the workshop aimed to discuss in more detail the needs for CS of specific tourism user groups. Based on the composition of workshop participants, "ski resorts" and "tourism associations" were selected as the tourism user groups to be discussed. For this exercise we applied the Value Proposition Canvas tool (see Figure 6). The aim of this tool is to gain a deeper understanding of the customer segment by interviewing experts and on this base to develop specific new ideas for the field.

The participants were discussing in two working groups firstly the status quo of their segment and then tried to develop new solutions by discussing with the other stakeholders in the group. The big advantage of this tool is to have the whole complexity on one page, to integrate new ideas and alternatives agilely and flexibly into the existing business model and to use the tool as a prototype to validate assumptions about the content with the respective experts.

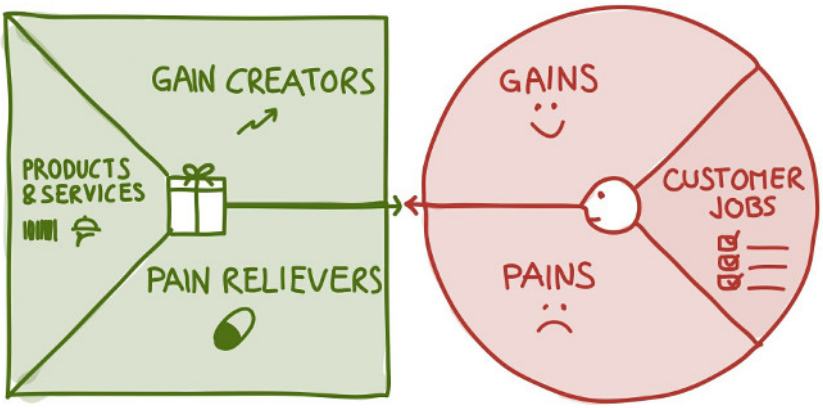

FIGURE 6: THE VALUE PROPOSITION CANVAS (© ALEXANDER OSTERWALDER)

On the right side of the canvas the customer is considered. The team focuses on a specific customer – this makes it easier to understand the pains and gains and to develop concrete new ideas and innovations based on those. The field 'customer jobs' describes all the steps the customer needs to do in order to run the business. The field 'pains' describes all the obstacles and pains the customer is facing every day (i.e. what makes it difficult to run the business). In the field 'gains' all the customers' wishes and dreams that will make his business easier are collected. Corresponding to this information, the left side of the canvas focuses on the products or services and the value proposition is described: It defines the bundle of products and services and features that create (individual) value for a specific customer segment. The value proposition defines why a customer is willing to pay money for the product or service. In the field 'products and services' all the features of the product, hardware and software or services are described. The fields 'pain reliever' and 'gain creator' aim to find answers to the previously identified pains and gains of the customer. Which idea or product could support the customer to do his or her business better, easier or more sustainable? This could be related to e.g. innovation, performance, climate impact, risk reduction, energy reduction, and usability. The aim of the canvas is to find the right problem-solution fit for the target customer.

Generally, one of the main reasons why businesses fail is that the providers do not exactly know the customer and market needs. This know-how is absolutely necessary for a successful business idea. One important aspect to identify the user needs is to think human centered. Putting the customer into the middle of the analysis will help to identify the real pains and gains of target customers and the target market. With this information it will be easier to name the added value and to modify the products and services right to the customer's and market needs. To observe the customer in their context, to understand the processes he/she depends on, to know the influencing factors, to understand the decision-making process, will again lead to more information to adjust the business. The willingness to pay for a product or service will increase as well. With this awareness climate services can be offered while addressing the real needs of the customer. Furthermore, the added value of the integration of climate services will be clear and can be implemented sustainably. All the collected information about the customer and the

market needs to be embedded in the wider context. For example, in the skiing sector not only the tourists' pains and gains need to be taken into account, but also factors influencing the service provision (like water availability for snow production, etc.) and environmental implications or political regulations in this regard. Ideas and again unaware influencing factors complete the big picture of information about the customer and market.

3.1.3 Complementary interviews

Following the insights we gained from the interviews and the workshop, focus was given to specific user groups and topics for the final interaction round. First, a meeting was organized with the manager of a local tourism association in Upper Styria, who also attended the stakeholder workshop in Graz, to discuss in more detail CS needs for a specific region: services for a tourism association and the region as a whole. Options for joint acquisition are also relevant aspects in this case.

Second, another meeting was held with the Climate Change Centre Austria (CCCA) to discuss improvements in communication & visibility of CS and their providers.

Third, a meeting was arranged with the project coordinator of the national meteorological service in order to discuss new business models and options for cooperation between climate data providers and purveyors.

3.2 Case study – Finland

3.2.1 Interviews

A series of semi-structured interviews were conducted to understand the context and perspectives of Finnish winter tourism businesses on climate services. The focus was mainly on Lapland, but in order to better understand the issue also ski resort representatives from other parts of Finland were interviewed.

The Finnish winter tourism sector is an intertwined structure of private and public organizations where municipalities, enterprises and provincial and national administrations all have a role to play (a simplified general conceptual structure is presented in Figure 7). Because of this, a set of interviewees representing the whole value network of winter tourism was sought for. After a stakeholder mapping process, a list of 39 experts was drafted. Eight of these experts were interviewed during the first round of interviews and five in the second round, which took place after the online survey. The categories of experts that participated in the interviews or the online survey are presented in Table 6.

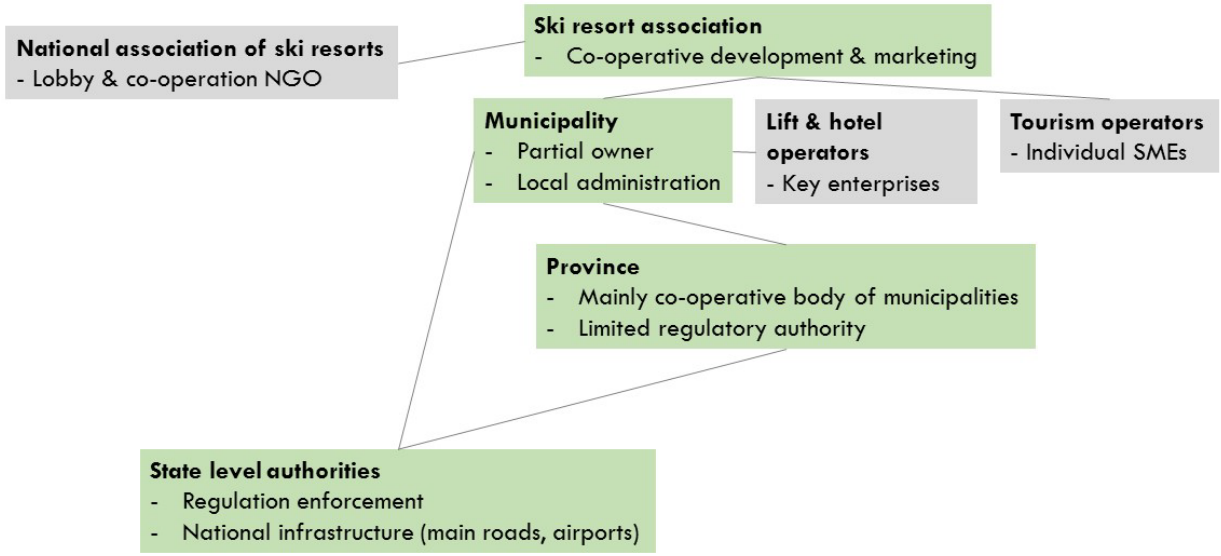

FIGURE 7: CONCEPTUAL MARKET STRUCTURE IN LAPLAND (MOST PROMINENT CS PROCURERS IN GREEN)

The interviews of the first round followed the guidelines discussed earlier in section 3.1.1and interviews revolved around the use of CS in tourism, perceived barriers to the use and provision and possibly unmet user needs, as well as general risk perceptions regarding climate and climate change. Interviews were also used to validate our model of organizational CS use landscape and networks.

TABLE 6: CATEGORIZING OF FINNISH STAKEHOLDER PARTICIPANTS

Tourism stakeholder	interviewed	survey
Ski resort representatives	4	1
Municipal and regional authorities	6	6
State authorities	4	2

3.2.2 Online survey

Following the first round of interviews, an online survey was prepared. Based on the interviews it seemed that climate risks beyond short term and seasonal variations were considered interesting but somewhat distant and not very relevant for decision-making at hand. To get responses that would be less generic, an online survey consisting of example climate information contextualized in decision-making was prepared.

The survey consisted of five predictions and related questions and one question about the preferable form of CS. The translated survey template is presented in Annex B as the original was prepared in Finnish. Each of the five questions consisted of an example prediction in a stylized easy to grasp fashion (i.e. '*The amount of snow in the Central European Alps decreases by half by the year 2050.*') followed by questions about the significance of such information and the actions it could lead to. The final questions presented the respondents with a slightly modified version of Table 5, asking which of such CS would be preferable and whether there would be willingness to pay for it.

The survey was sent to 30 experts, and got eight responses. Originally, this phase of work was planned as a workshop, but due to the low interest and possibility to participate, the workshop was cancelled in favor of a survey. This change naturally affected the amount of interaction with and between the stakeholders, but it enabled collecting a more articulated set of views and specific feedback on different types of climate related information. At the same time a survey is not the ideal tool for collecting detailed views on service design. However, the interviews indicated that the interest towards elaborated services is limited.

3.2.3 Complementary actions and interviews

After the survey, a brief summary leaflet about the preliminary results of EU-MACS supplemented with additional tips and information was prepared and sent to the stakeholders. The aim was to raise awareness and disseminate EU-MACS and MARCO findings and remind the stakeholders about the project. The leaflet got positive response, with several stakeholders enquiring about the possibility to disseminate it further (which was granted). The translated leaflet is presented in Annex C (the original is in Finnish).

After the leaflet distribution, a second round of interviews took place in January and February 2018. Here, six stakeholder experts were interviewed with the aim to validate the earlier results and check if some major themes or issues were missing. The interview structure was simplified and the emphasis was on specific CS related questions.

4 EMPIRICAL RESULTS – AUSTRIA

4.1 Results from interviews with end-users

4.1.1 Risk perception

Climate change is perceived as a risk for winter tourism by most interviewees, but opportunities for mountain tourism in summer are mentioned by interviewees as well. Due to cooler temperatures Alpine summer tourism destinations could gain comparative advantages, especially in very hot summers. In terms of economic value added, however, summer tourism will not be able to compensate losses in winter tourism as tourist expenses are higher in winter.

In general, no person interviewed pronounced skepticism towards climate change, but they referred to the lack of risk awareness of the tourism sector as a whole, especially within the ropeways sector:

> "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."
>
> *(Chamber of Commerce – Head of 'Tourism and recreation' department)*

The perceived risk level of the interviewed stakeholders depends on the type of stakeholder and the region. While tourism associations in the Eastern 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 skiing tourism, tourism associations in winter tourism dominated provinces in western Austria assess their region's current climate vulnerability at a higher level. The highest current vulnerability is felt by interviewed stakeholders from ski resorts and the interviewed sports equipment producer. Nevertheless, the perceived vulnerability among the interviewed ski resorts is diverging. Those interviewed ski resort operators who do not use customized climate services yet rate their vulnerability lower. The interviewed persons from the hotel sector perceive the current climate vulnerability as quite moderate, with differences in the rating with respect to the tourism region (alpine vs. non-alpine tourism regions).

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

A manager of hotels in wine regions in Styria and Lower Austria refers to the adaptive capacity of the tourism sector. She believes that climate change will not affect her tourism business dramatically.

> "Higher temperatures could improve the quality of the wine and lead to a better image which could increase tourism demand. […] Skiing destinations experience losses, especially those under 1000 m altitude, but the tourism sector could adapt to the changing climatic conditions (winter tourism regions could find new strategies, e.g. being an event destination in winter). Travel motives and the duration of stay will change."
>
> *(A manager of hotels in wine regions in Styria and Lower Austria)*

The interviewed stakeholders seem to be more concerned about short-term impacts of adverse weather conditions and inaccurate weather forecasts than long-term changes in the climate. The tourism sector is seen as highly dependent on favorable weather conditions. The interviewees refer to the high flexibility of tourists in case of adverse weather conditions. Last minute bookings have been increasing due to the increased use of weather apps. The actual extent of a tourism offer's weather sensitivity is dependent on the travel motive, though. Cultural tourism, for example, is noticed to be less weather dependent: "*Once you have bought the festival tickets you travel regardless of the weather forecast*" was stated by a hotel manager. The transport mode and travel distance is also seen to play a role in determining the likelihood of cancelling a trip because of bad weather forecasts. If no public transport ticket has been booked yet, tourists are more likely to cancel the trip and look for touristic alternatives.

One interviewee is afraid that more transparency in weather conditions will further increase the trend to short-term booking. Currently the weather risk is mostly taken by the tourists. However, in future the tourists' demand for more favorable cancellation conditions could increase. The interviewee believes that more and more tourists will only book a trip if they have the right to cancel for free at short notice. From the stakeholder's point of view, this could be problematic, if the weather risk is totally passed on to the tourism service provider. Here, weather insurances could be an option.

A broad diversity of tourist offers could help to reduce a tourism company's climate vulnerability. The interviewed recreational facilities manager refers to their diverse offer of outdoor pools, indoor pools, wellness, summer toboggan runs as well as mountain railways and cableways. The interviewed hotel managers perceive themselves to be less weather-dependent, because of indoor offers such as wellness, indoor pools, fitness centers, massages and cosmetic treatments. If the main travel motive is related to an outdoor activity or event (e.g. the visit of wine taverns and festivals in autumn, etc.), the interviewees observe a higher weather-sensitivity of hotel guests, though. Furthermore, the wellness tourism segment is seen to compete with other travel motives: Good snow conditions in skiing resorts, for instance, lead to less demand in solely wellness-oriented hotels and tourism regions.

A trend to all-season tourism is observed by the interviewed stakeholders already today. Tourism service providers are investing more and more in indoor activities in order to be less weather-dependent and all-season sports are becoming increasingly popular (e.g. biking, golf, and hiking). Even large winter tourism destinations start to pursue the strategy of developing towards an all-season tourism destination (for economic reasons). The interviewees also notice a trend towards the extension of seasons to increase the occupancy rate of tourism businesses in order to extend the staff's duration of employment (it is difficult to find employees for a seasonal employment). Some interviewees, however, indicate that climate change might be just one of several reasons for an increase in summer tourism. Other factors include influencing the travel behavior and recreational activities. In general, practicing particular kinds of sports underlies societal trends which change constantly. Health consciousness is increasing as well, which has to be considered in tourism marketing strategies, as stated by a tourism association.

In the Eastern – less mountainous – parts of Austria the current climate risks faced by the tourism sector are perceived as low to moderate. The tourism offer is diversified and ski tourism plays only a minor role. For the province of Burgenland, which does not host any ski areas with more than one drag lift and has not been strongly affected by climate variability and change so far, climate change has not been an important topic yet. However, due to the expansion of all-season tourism in many other – formerly more winter tourism dominated – Austrian destinations, Burgenland has to compete with an increasing number of other tourism regions. Many Austrian winter tourism destinations have already successfully combined

wellness and skiing. Hence, "*even though Burgenland is currently not that vulnerable to climate variability compared to other regions, it could be increasingly challenged to position itself on the tourism market and to find market niches due to adaptation measures taken by other regions*", concluded the interviewed person from Burgenland tourism.

Burgenland tourism also indicates the importance of developing sustainable touristic mobility concepts. "*More and more young people, especially in urban regions, do not learn to drive anymore, which is problematic for tourism regions which are not well integrated into the public transport network, like the south of Burgenland*". Overall, sustainable tourism is seen to having gained importance in the recent past, even though it is still a niche product. According to the national hotel association, considerably more tourism companies devote themselves to sustainable tourism than ten years ago and hold respective certificates.

TABLE 7: RISK PERCEPTION OF THE INTERVIEWED STAKEHOLDERS

	Current vulnerability	Future vulnerability	Risk perception
Tourism associations [5] (Eastern provinces: Vienna, Burgenland, Styria, Lower Austria, Upper Austria)	1-2	3-4 (west) 2-3 (east)	– Climate change will affect tourism positively and negatively. – Opportunities for summer tourism, but extreme events could also affect summer tourism negatively. – In the non-alpine regions of Austria the vulnerability of the tourism sector is rather low: tourism offer is diversified (business and health tourism, which is less weather dependent); skiing is not the major branch. – Due to large investments in snowmaking, ski lift operators are prepared for snow poor winters. – Climate change affects travel behavior. Tourists react very flexibly on weather and climate conditions. – All-season sports and tourism is becoming more popular (in economic terms, however, there is no alternative to winter tourism). – Societal trends in sports (climate is only one factor). – Vienna: Summer temperatures and extreme events have been increasing. Adaptation measures to deal with urban heat have already been taken (drinking water fountains, shading of public places, requirements of air conditioning in hotels, etc.). Vienna could become less attractive for tourists in future.
	2	2(-3)	
	2-3	-	
	1-2	2-3	
	2	3	
	3	3	
	-	-	
Tourism associations [2] (Western provinces: Tyrol, Vorarlberg)	3	-	– Climate variability influences winter tourism ("it always has and will continue to do so"). Climate change will impact winter tourism. – There is a trend to all-season tourism already today. – Vulnerability will decrease in future due to the adaptive capacity of tourism regions (opinion of one interviewee).
	3-4	(2-) 3	
Chamber of Commerce [1]	-	-	– The trend towards all-season tourism is increasing the occupancy rate of tourism businesses. – Tourism service providers are investing more and more in indoor activities.
Public administration [1]	-	-	–
Hotel association [1]	-	-	– Summer tourism has increased in the recent past (currently not assessable, if climate change contributes to this positive trend). – Vienna could become less attractive for tourists.

			– More and more tourism companies consider sustainable tourism and are certified.
Hospitality industry [2]	2-3	2-3	– Tourism demand is highly influenced by the weather. – Last-minute booking has increased (due to weather apps). – Hotels are less weather sensitive. – Hotels could be affected by extreme events (e.g. floods). – Cultural tourism is less weather sensitive. – Good snow conditions in skiing resorts lead to less demand in purely wellness oriented hotels / regions. – Climate change will not affect the tourism region (wine regions in Styria and Lower Austria) dramatically. Quality of wine could be improved due to higher temperatures. Skiing destinations will experience losses, but could adapt to the changing climatic conditions. – Travel motives and the duration of stay will change. – Trends towards all-season tourism.
	3	4	
Ski resorts [5]	4	-	The perceived vulnerability partly differentiates noticeably among the interviewed ski resort operators, ranging from low vulnerability (due to snowmaking) to high vulnerability (despite snowmaking): – Ski resorts are highly vulnerable (opinion of three ski resort operators). – The winter season 2006/07 was a nightmare for ski resorts, in particular in the eastern parts of Austria, with turnovers of only 50 % compared to a normal season. However, snowmaking capacities were lower at that time. – Lack of "winter feeling" in urban areas affects skiing tourism. – Strategies to focus on all-season tourism and to reduce the snow-dependency of tourism products are being developed. The aim is to reduce the vulnerability in future. – Climate has always been an influencing factor. Due to snowmaking climate variability can be handled quite well. Those who have already adjusted to climate variability (by means of snowmaking), will also survive in future. – Often only the small ski resorts without snowmaking infrastructure are presented to being threatened by climate change. Those ski resorts, however, are mostly operated by municipalities or associations, which are not economically dependent on skiing operations. They were not profitable 20 years ago either. – In the past three years, less cold days for snowmaking were observed. However, fluctuations in snow and snowmaking conditions mostly balance out over the season. – In former times 1-2 of 10 were extreme seasons; nowadays there are 4-5 of 10. Nevertheless, the number of operating days has been increasing over the years. – Calendar effects (e.g. Christmas on a weekend) have a higher impact on the economic performance than climate variability. – There are climate opportunities for summer tourism (opinion of all interviewed ski resort operators).
	4-5	-	
	-	-	
	2	2-3	
	2	2.5 - 3	
Recreational services [1]	-	-	– Tourism is highly dependent on weather and climate conditions. Given the nature attractions, the recreational sector is highly weather dependent.

			– A broad diversity of a company's offers (outdoor pools, indoor pools, wellness, summer toboggan run, mountain railway/cableway) reduces the weather sensitivity for the company as a whole, but nevertheless, the company is still sensitive to adverse weather conditions. – Extreme precipitation events have been increasing in the recent past and the consumer behavior is influenced by these events. – The consumer has to adapt to changing climatic conditions.
Sports equipment production [1]	4	-	– The climate vulnerability is very high. The production and sale of alpine sports equipment is less weather-sensitive due to technical snow production in ski resorts. The production and sale of Nordic sports equipment is very sensitive, though.

4.1.2 Current use of climate services

Besides a few exceptions, the current use of customized CS is mainly limited to ski resorts (e.g. studies on current and future snow reliability and snowmaking potentials, etc.) and provincial governments or provincial tourism associations (e.g. commissioned regional studies on climate change impacts). For the daily operational business, weather services such as weather forecasts are commonly used by tourism businesses. Many tourism businesses (associations as well as companies) buy local weather forecasts, other just use the publicly available forecast websites and apps. Ski resorts often use tailored weather forecasts for snow production management and to decide e.g. when to close a lift in case of storm events. Many hotels and tourism associations buy tailored weather forecasts to provide them on their websites and use the forecasts to organize outdoor sports activities, etc. Some tourism associations combine the weather forecasts with recommendations for recreational activities suitable for the prevailing weather conditions and offer this service on their websites. Live cams are also considered as important for tourists.

Two interviewed tourism businesses – one ski lift operator and the operator of recreational services (outdoor/indoor outdoor swimming pools and wellness centers) – use WEDDA® (by Joanneum Research), a short-term demand forecasting tool based on weather forecast data, which supports the disposition of staff, merchandise purchase and the planning of food preparations in the restaurant kitchens.

Historic/current climate statistics

The duration of sunshine is a topic of tourism marketing e.g. in the non-alpine state of Burgenland. About 15 years ago Burgenland started to promote the province as an all-season tourism region, comprising spa and health tourism, which is less weather-dependent. Therefore, in the past a study was commissioned to analyze the (historic) climatic conditions of the province.

Climate diagrams are presented on the website of the Vienna Tourist Board, but no further climate information or service is currently used.

Climate impact studies

Regarding the long-term perspective, many interviewed stakeholders – in particular tourism associations and other interest groups – stated to read general climate (impact) studies which are publicly available. Some interviewees refer to seminars/workshops and the media as sources of CC information.

The spatial resolution of publicly available studies, however, is often too coarse to derive conclusions for a particular tourism region, as mentioned several times. Some provincial tourism associations therefore commissioned studies on climate change impacts on tourism at provincial/regional scale. The results are shared with other tourism stakeholders (e.g. local tourism associations). In some provinces workshops were organized to present and discuss the results. "Raw" climate data is usually not used and combined with other data in-house.

In current tourism strategies climate and climate change adaptation plays only a minor role, especially in the non-alpine states of Austria, such as Burgenland. There are, however, provinces that already considered climate change topics in past strategies and several representatives of provincial tourism associations stated that climate is or will be considered in the development of the tourism strategies for the next planning periods, "as it is a crucial factor for strategic planning in the future" (Destination manager, Upper Austria tourism).

Hotel association

The national hotel association prepares and provides information for their members and organizes information seminars. Topics such as climate, climate change, and sustainable tourism are covered as well, but only represent small parts of a huge variety of topics important to the hospitality sector. According to the impression of the interviewee, the climate change (impacts) topic has somewhat lost in popularity, whereas information on sustainable tourism, energy costs and potential savings are requested more often. The hotel association frequently commissions studies and guidelines and often takes an active role in their preparation to ensure a language adequate for the hospitality sector and the inclusion of concrete measures. They commissioned and co-developed guidelines on energy use and sustainable food offers, and a study on e-mobility. Publicly available studies are also used and relevant information is shared with the members. It is important that the studies include concrete adaptation and mitigation options; – "*what can I do in my business, what is the benefit of considering climate change*" etc.

Ski resorts

The ropeway industry is the main tourism branch which currently uses typical customized CS and certainly has the highest market potential of using customized CS at business level. Although the sector is still skeptical towards climate change, there are at least some ski resorts – mostly in the eastern, low-lying areas of Austria – which already see the need for customized information on current and future snow reliability and snowmaking potential. Among the five interviewed ski resorts, three have already used customized services. Some customized services are based on funded research projects.

According to the interviewees, the spatial resolution of publicly available general impact studies is too coarse to be relevant for an individual ski resort's decision making and studies which only consider natural snow are not useful for ski resort operators anyway as most ski resorts already use technical snow production. Customized services, on the contrary, offer the advantage of snow simulations calibrated to the individual ski resort, depicting also the actual snowmaking capacity of the respective ski resort. An adequate temporal resolution is also mentioned to be of high importance. If "available snowmaking hours" represent the climate service delivered, ski resort operators are not only interested in the total number of available hours, but also in their quality in terms of associated wet-bulb temperatures. This requires temporal resolutions below the daily level for the underlying analyses. Overall, interviewees perceive large-scale studies to be based on assumptions simplifying to such an extent that results are rather useless for snowmaking management and planning of individual ski resorts.

The tailored study results are used for investment and strategic decisions, to decide e.g. about the expansion of snowmaking infrastructure, the required size of water reservoirs, or the closure of parts of a ski resort as happened in Lower Austria. The snowmaking infrastructure of the closed parts is now used in other parts of the ski resort which show a better future prospect with respect to snow reliability. Furthermore, the ropeway company largely invested in the development of a summer and all-season tourism concept: a summer toboggan run, a motor skills park, and mountain bike trails.

The main reason of another ski resort for commissioning a study was to get a neutral and objective decision basis for the local council whether to further invest into the ski area (snowmaking infrastructure, chair lift, …) and an expert analysis that – depending on the outcome and the resulting investment decision – could potentially be attached to an application for public investment subsidies at the regional government. The study provided the basis for decision-making and comprised information on current and future snow reliability and snowmaking potentials of the ski resort and a climate proofing of planned investments. More detailed information on two use cases are elaborated in Deliverable 5.10 of the MARCO project (Köberl *et al.* 2018).

TABLE 8: CURRENT USE OF CLIMATE INFORMATION OR SERVICES BY THE INTERVIEWED STAKEHOLDERS

Stakeholders	Type of service	Current use
Tourism associations [9]	*Monitoring/ Historical*	– Climate diagrams / statistics for particular destinations (current climate)
	Short-term	– Daily weather forecast data (commercial and/or non-commercial) – Local weather forecasts for touristic events – Local weather forecasts (and tools) to derive and offer weather-based recommendations for recreational activities
	Strategic	– Publicly available studies on climate change impacts – Commissioned studies on climate change impacts at provincial scale (in case of provincial tourism associations)
Chamber of Commerce [1]	*Strategic*	– Publicly available studies on climate change impacts
Public administration [1]	*Monitoring/ Historical*	– Live cams (in case of municipalities)
	Strategic	– Commissioned studies on climate change impacts at provincial scale
Hotel association [1]	*Strategic*	– Publicly available studies on climate change impacts – Commissioned studies on sustainable tourism / handbooks
Hospitality industry [2]	*Short-term*	– Weather forecast data (commercial and/or non-commercial), Live cams – Early warning systems (flooding, avalanches, storms) – Local weather forecasts (and tools) to derive and offer weather-based recommendations for recreational activities based on weather forecasts
	Strategic	– Publicly available studies on climate change impacts / CC information from the media
Ski resorts [5]	*Monitoring/ Historical*	– Data from own weather measurement stations – Live cams – Weather-adjusted performance monitoring
	Short-term	– Weather forecast data (commercial and/or non-commercial) – Weather driven short-term demand forecasts
	Strategic	– Customized studies on current and future snow reliability and snowmaking potentials – Climate-proofing of investments

		– Participation in research projects as case study regions – Publicly available studies on climate change impacts / CC information from the media / presentations of CC results
Recreational services [1]	*Monitoring/ Historical*	– Weather-adjusted performance monitoring
	Short-term	– Weather driven short-term demand forecasts
	Strategic	– Publicly available studies on climate change impacts
Sports equipment production [1]	*Strategic*	– CC information from the media

4.1.3 Perceived barriers to the use of CS

According to the interviewed stakeholders, one of the main barriers to using climate services in the tourism sector is the short planning horizon, which is five years ahead at maximum. Hence, long-term developments such as climate change are rarely taken into account. Weather variability is more important to tourism businesses than a long-term view. Tourism businesses are increasingly confronted with short-term, last-minute booking behavior. They are affected by the high usage of weather-apps and in particular by inaccurate weather-forecasts (incorrect forecasts of bad weather conditions may keep visitors and tourists away despite actual good weather conditions).

Many interviewed stakeholders believe that the lack of risk awareness is a reason why climate services are not used to a larger extent yet.

> "Climate change is not taken seriously (in the tourism sector). People think that they cannot do anything against it. […] Weather/Climate is as it is; nobody wants to put effort into it."
>
> (A representative of a tourism association)

One interviewee feels that a couple of years ago climate change impacts have been discussed more intensively in the tourism sector.

Some stakeholders also see the uncertainty of climate scenarios as a reason for not using climate services. Furthermore, the interviewees feel that people often do not know where to find reliable information about climate change impacts on tourism. Conflicting messages in the media hamper the use of climate information and services.

In particular the ropeways sector is skeptical towards climate change. In the past, representatives of the ropeway sector often denied the impacts of climate change. An interviewee sees one reason for the skeptical attitude of the ropeways industry and ski resorts in the increasing pressure by the media which started to question their role as tourism driver. "So, it is easier for them to say '*we have always had snow-poor winters*' and to rely on studies which deny changing climatic conditions", he concludes. In addition, generic studies about climate change impacts on the snow reliability of ski areas partly caused dissatisfaction among ski area operators, as (too) generalized assumptions and statements presented a threat for their creditworthiness. Due to technical snow production the sector often plays down the threats of climate change for the ski tourism sector. Ski resort operators do not see a problem yet for their

business within the operating life of snow cannons, which is about 15 years. Nevertheless, there seems to be a slow change in the attitude of the ropeways sector towards climate change.

The use of climate services is a matter of personal attitude towards climate change. An interviewed ski resort operator believes that the "old generation" of ski lift operators is more skeptical towards climate change. The younger generation tends to have a higher awareness of climate risks and more likely considers climate change in their strategic planning and investment decisions.

> "In the golden times of ski tourism (in the 1970s), the old generation of ski resort operators did not need to worry about their business and did not need to think about market research. They had kind of a protected workplace."
>
> (A ski resort operator)

The ski resort operator also concludes that, compared to other sectors, it seems to be less common in the ropeways sector to underpin business decisions with scientific studies, but that the new generation of ski resort operators – the change is ongoing – is more receptive to scientific results.

The interviewed person from the hotel association assumes a potential reason for the low use of climate services in the already applied adaptation strategies. Ski lift operators, for example, invested a lot in snowmaking infrastructure and might feel sufficiently equipped to deal with current climate variability. Hence, the sector may currently lack sufficient pressure to see a need in thinking about further adaptation strategies. It is mentioned several times that tourism businesses would only start thinking about adaptation options when the consequences of climate change had already been experienced by themselves. The pressure has to be high enough. Hence, current vulnerability plays an important role in potentially using climate services. Those tourism regions and businesses that have suffered already from climate variability and extremes are more interested in the topic and are more willing to pay for customized climate services and assessments of future impacts and adaptation options. A ski resort operator stated though, that climate services are only interesting for those ski resorts which are not already in financial troubles. Those who already suffer financially would not have the budget for the necessary investments.

Preparing one's own business-related data, which is needed for a customized CS, is another big barrier for using CS, as indicated by a ski resort operator. According to the interviewee, it seems to be generally difficult to convince ski resort operators to participate in studies, i.e. to provide data, no matter whether they are climate related or not. The benefits of using CS are not perceived as high enough by the CEOs of ropeways to take the time for preparing the required data.

Overall, there seems to be a lack of awareness about the benefits of CS use. The chamber of commerce believes that tourism service providers are not willing to pay for such tools and services as long as they do not see the benefits for their businesses. To overcome this barrier, improved communication and demonstration of the user value of weather and climate services is suggested by interviewees. The chamber of commerce, for instance, proposes the offering of a free – or at least low-cost – trial period to allow potential customers testing the service on its particular value for their business.

The spatial resolution and regional relevance of climate change impact studies is mentioned several times as an obstacle for using climate information. Stakeholders often claim that the impacts determined at large-scale do not apply to their region and hence they do not see the need or possibilities to undertake

actions. Breaking down the results for a particular region entails costs, which often cannot be taken. Financial constraints are mentioned several times as a major obstacle to use climate services. Tourism associations and individual tourism businesses, especially the small ones, do not have the budget for customized climate services. Tourism associations refer to their main function which is marketing and product development. Some interviewees, however, believe that if people are aware of the benefits of customized products, the costs are not an impediment of using them. "*Funding for flood protection is also raised. So, if it is required, budget should be available for climate services as well*", one tourism association concludes. One current user of weather-based demand forecasts states that compared to the benefits, the costs of (weather) services do not play a role. He rather sees the innovational strength of companies still being missing. He believes that weather-based demand forecasts could help in many sectors and also sees a large potential in weather insurances, e.g. hedging the risk of the recreational sector (rainy weather – unfavorable for outdoor-pools etc.) and the energy sector (dry weather – unfavorable for hydropower production).

TABLE 9: PERCEIVED BARRIERS BY THE INTERVIEWED STAKEHOLDERS

Stakeholders	Type of barrier	Perceived barriers
Tourism associations [9]	*Awareness*	– Lack of risk awareness – Lack of awareness about the benefits of CS use
	Priorities	– Low financial pressure
	Lack of trust	– Conflicting messages on climate change presented in the media
	Capacity/Resources	– Financial constraints
	Applicability	– Spatial resolution of existing studies (downscaling entails costs) – Long-term projections are too abstract and climate change is often presented as catastrophe
Chamber of Commerce [1]	*Awareness*	– Lack of risk awareness – Lack of awareness about the benefits of CS use
	Priorities	– Low financial pressure
Public administration [1]	*Awareness*	– Lack of risk awareness
	Priorities	– Low vulnerability in the non-alpine regions (no winter tourism)
Hotel association [1]	*Priorities*	– Snowmaking as adaptation strategy currently sufficient – Low financial pressure
Hospitality industry [2]	*Awareness*	– CS providers not known
	Priorities	– Short planning horizon in the tourism sector (5 years at maximum) – Weather/climate not that important compared to other factors – Hotel guests are less weather-sensitive
	Capacity/Resources	– Financial constraints
	Applicability	– Cost-benefit ratio of weather-driven demand forecasts insufficient, no flexible pricing scheme, staff planning and merchandise works very well
Ski resorts [5]	*Awareness*	– Lack of risk awareness – "Old generation" of ski lift operators not open-minded – Lack of awareness about the benefits of CS use
	Priorities	– Lack of time and interest for preparing one's own business related data needed for customized CS – Snow production as adaptation strategy sufficient
	Capacity/Resources	– Financial constraints

	Applicability	–	Questionable reliability of results at small scale
	Lack of trust	–	Skepticism towards CC among ropeway sector
		–	Conflicting messages on climate change presented in the media
Recreational services [1]	*Priorities*	–	Missing innovational strength of companies
	Lack of trust	–	Uncertainty of climate scenarios
Sports equipment production [1]	*Lack of trust*	–	Uncertainty of climate scenarios

4.1.4 User needs

Communication

Stakeholders believe that there might be a lack of knowledge among many people in the tourism sector where to find (reliable) climate information and services. According to a hotel manager, actors who are interested in the topic search for information in the internet, but it would be useful to know about an institution which could be trusted to publish reliable information.

One stakeholder suggested distributing climate information and products via sector representatives at national level (in particular the ecology committees and economic committees) who should then forward the information to the provincial and regional tourism associations. Directly contacting the sector representations at provincial level is not rated as very promising by the interviewee. Another interviewee finds that a newsletter presenting the latest findings of tourism related climate research could be useful.

How scientific results are communicated is regarded as highly important. According to the interviewed stakeholders, climate information needs to be understandable, i.e. study results have to be presented in simple language understandable by non-scientists. Furthermore, the particular consequences for tourism actors have to be demonstrated. The interviewed stakeholders also see a need in improving the communication on how results have to be interpreted.

Format of CS

Climate services need to be concrete and beneficial. 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. Stakeholders prefer to have a short and compact preparation of main results (graphical illustrations including explanations), comprising conclusions that can be drawn. 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. Hence, consultancy services are most relevant for tourism stakeholders.

One tourism association stated that the desired format of a CS depends on the use case. Regarding the development of tourism strategies, the CS in form of a presentation or consultancy is relevant. In case of decision support e.g. for investment decisions, an online-platform providing easily accessible and intuitive information for different regions is regarded as useful.

Another mentioned need is fast service delivery. Practitioners require project results and consultancy services to be delivered within a short time period (a couple of months). Classical research projects often take too much time.

Spatial scale

Tourism associations wish to have detailed information for developing climate-proof tourism strategies. That is, they need regional information on which tourism activities will (still) be possible in the future and should therefore be promoted and which should not be pursued in particular regions anymore. In general, a detailed analysis of impacts at regional scale, i.e. the downscaling of results to each tourism region or business, and the development of adaptation strategies is stated to be highly relevant.

Tourism demand / Travel behavior

Many interviewees showed interest in (more) information about climate change impacts on tourism demand, i.e. how travel behavior might change in future. Since climate is only one of many influencing factors of tourism demand, interviewees also refer to societal trends and demographic changes which have to be considered in the analysis of future tourism demand. One representative of the Vienna Tourist Board stated his interest in an international comparison of climate change impacts on urban tourism.

To quantify how much the lack of winter feeling (e.g. in cities) will affect ski tourism demand in future is a question of interest for an interviewed ski resort operator: "*The lack of natural snow at the beginning of the winter season affects the skiing business significantly. This is what we experience already today. If it has 15 °C in cities, nobody is aware that skiing in the mountains is possible (despite promotion)*".

Short-term tourism demand forecasting tools (currently used e.g. by ski resort operators, outdoor swimming pool operators, etc.) are not perceived as particularly useful for the hospitality sector. According to one of the interviewees from the hospitality industry, "*the guest behavior is well known anyway*". "*We do not have a flexible pricing scheme and also staff planning and merchandising works very well. […] The number of hotel guests is sufficiently predictable in advance, despite short-term booking and cancellations*". The interviewee doubts that the cost-benefit ratio of such tools pays off for hotels and small touristic attractions, but considers the service more useful for larger tourism service providers, in particular tourist attractions which are also visited by day-trippers. Large ski resorts with high investments could be more interested in such demand forecasting tools. However, the interviewee indicates that those businesses have to experience substantial financial losses before buying this kind of a service.

Summer tourism / Multi-sectoral perspective

The market potential for CS concerning summer tourism is perceived as rather low by most interviewed stakeholders. The benefits of CS for the winter tourism industry are more obvious than for summer tourism. Detailed information on snow reliability and snowmaking potential at different altitude levels and exposition are considered as useful for snow management and strategic planning of snowmaking practices. "*No large investments have to be undertaken for summer tourism, hence, climate plays a minor role*" concludes the interviewed hotel manager. Since the alpine summer tourism will likely benefit from climate change, tourism service providers do not see a need for customized CS as no financial losses have to be expected. There are doubts that more detailed information on climate change impacts on summer tourism has an added value for the summer tourism industry.

On the other hand, tourism associations state that they wish to have more information on the impacts of climate change on summer tourism and shoulder-season tourism. Overall, the multi-sectoral perspective is seen to be of high relevance, comprising mobility and regional planning; climate change impacts on agriculture/ecology and the implications for tourism, etc.

Products

The interviewed tourism associations generally express interest in tourism monitoring fact sheets, including statistics of weather/climate and demand indicators. Presenting climate statistics (mean temperatures, duration of sunshine etc.) on their websites to support tourists in their travel decisions is generally considered as useful. (Remark: The willingness to pay for it is not clear).

One of the interviewed hotel managers states his interest in a constantly updating app that shows weather forecasts and respective recommendations for recreational activities. (Remark: Such services are already in use by some hotels and tourism associations).

Modelling improvements

Users of customized CS which are based on snow modelling refer to the needs of improvements in modelling Foehn events and extreme precipitation as well as the water flow rates in the pipes for snowmaking.

Weather services

It is mentioned several times that the inaccuracy of weather forecasts causes damages for the tourism industry as tourists react very flexibly on bad weather forecasts. A tourism association expresses the wish for a higher density of weather measurement stations in order to increase the accuracy of forecasts.

Seasonal projections

The interviewed stakeholder from the sport equipment production sector shows interest in reliable seasonal climate projections and seasonal demand models (based on equipment sales). Overall, he regards seasonal projections as principally useful for operational planning, but strongly doubts their current applicability due to the lack of reliability.

TABLE 10: PERCEIVED USER NEEDS FOR CS BY INTERVIEWED STAKEHOLDERS

Stakeholders	*Type of needs*	User needs
Tourism associations [9]	*Communication*	– Better communication of scientific results & CS providers – One institution that could be trusted to provide credible information – Demonstration of adaptation case studies
	Applicability & Format	– Climate change impacts and adaptation strategies at local/regional level (high spatial resolution) – Compact preparation of main results and conclusions, consultancy services most relevant
	Monitoring/Historical	– Climate statistics on websites (for summer tourism) – Tourism monitoring fact sheets including climate conditions and economic performance could be useful
	Short-term	– Improved weather forecasts / High density of measurement stations – Reliable seasonal climate projections
	Research	– More research on impacts on summer tourism and shoulder-season tourism – Research on climate change impacts on ecology and agriculture and implications for tourism – Information on changes in travel behavior (climate and non-climate induced)

		– International comparison of climate-induced changes in urban tourism
Chamber of Commerce [1]	*Communication*	– Better communication of scientific results & CS providers
Public administration [1]	*Strategic*	– Climate change impacts on regional economy
Hotel association [1]	*Strategic/ Applicability*	– Climate change impacts and adaptation strategies at local/regional level (high spatial resolution) (demanded by tourism businesses and organizations, not by the hotel association)
Hospitality industry [2]	*Communication*	– Better communication of scientific results & CS providers
	Applicability & Format	– Climate change impacts and adaptation strategies at local/regional level (high spatial resolution) – Consultancy services
	Short-term	– App for activity recommendations based on weather forecast (already in use by some institutions)
Ski resorts [5]	*Communication*	– Better communication of scientific results & CS providers – A newsletter including the latest findings
	Short-term	– Improved weather forecasts / High density of measurement stations – Free access to highly resolved weather forecast data
	Strategic	– Economic impacts of climate change and impacts on skiing demand could be useful
	Research	– Research on influences of "winter feeling" on skiing demand – Improved climate and snow modelling: foehn events, extreme precipitation, water flow rates in pipes
Recreational services [1]		– No need for customized climate services (regarding the long run).
Sports equipment production [1]	*Short-term*	– Reliable seasonal climate projections – Seasonal projections of equipment sales could be useful
	Research	– Impacts on skiing and cross-country skiing conditions (snow cover etc.) (Alps, South Scandinavia, North East of USA).

4.2 Results from interviews with CS providers

4.2.1 Current CS supply

In Austria and Europe, the market for climate services is dominated by research institutions. Most of the interviewed researchers do not regard themselves as classic CS providers, as they mainly work on funded research projects and primarily do not offer and promote CS on a commercial basis. Some of these projects may however result in, develop to or become the basis of climate services. Customized snow reliability and snowmaking potential studies for individual ski resorts are the most frequent CS provided on a commercial basis. According to the interviewees, who offer such services, they are demanded on average 1-2 times per year. Customers are mostly ski resorts which are owned or co-owned by public authorities. One interviewed CS provider also conducted a climatological review for a ski resort that annually holds one of the FIS races. The review was about the climatological feasibility of shifting the event to March.

Most interviewed researchers do not explicitly or intensively promote their services. More often, analyses at local or regional level are undertaken within applied research projects, in which tourism stakeholders

are directly involved (e.g. as partners). These studies are often funded by provincial or national governments.

The topics addressed by the interviewed researchers within funded research projects and relevant for CS (development) include snow reliability studies (taking technical snow into account), trends in historic time series of snow cover, drought and impacts on water supply, glacier monitoring, permafrost degradation, impacts of CC on different types of tourism, CC impacts on travel behavior, adaptation strategies, carbon footprints of ski resorts, etc. In addition, one interviewed institution provides environmental reviews and "ski audits", in which climate is one of several criteria.

Regarding current CS supply, the NMS focuses on classic services (e.g. climatological reviews, meteorological data collection and analysis). The methodological basis for CS is often developed within funded research projects. According to the interviewed research coordinator, one successful CS of the NMS for the winter tourism sector represents the customized analysis of (future) snow reliability and snowmaking potentials. Another – more general – service offered by the NMS is the "Klimatothek" (www.zamg.ac.at/cms/de/klima/klima-aktuell/klimatothek). This is a publicly available web-based service, which shows the deviations of measured weather conditions from a selected day, month, season or year in comparison to the reference period (1961-1990 or 1981-2010). For climatic health resorts, the NMS prepares the bioclimatic assessments required by law. These assessments inform about all climate elements, e.g. temperature, precipitation, wind, sunshine duration and depth of snow, at a particular destination or region.

The private company Weatherpark provides wind comfort and human comfort analyses at a local scale which are used for urban and building planning. Customers typically include urban planners, architects, real estate developers and city governments. Occasionally, their areas of service application are also related to the tourism and recreation sector. This includes for instance the optimization of pub gardens with respect to wind comfort in the course of newly planned projects. Another potential area of application related to the tourism and recreation sector, that however has not been materialized yet, is the development of wind protection measures for ski jumps. According to the interviewee, product development is funded by research projects and to some extent by own resources. Typically, the provided CS comprises a report but the most relevant part of the service is consulting.

One interview partner is involved in the H2020 demonstrator project PROSNOW which aims at building a demonstrator of a meteorological and climate prediction system from one week to several months ahead applied to snow management, specifically tailored to the needs of the ski industry.

The interviewed tourism consultant provides services that comprise training/education (for destination managers, travel agencies, students and policy makers) and support in product development and processes, policy advice and strategy development. Concerning climate, he is involved in projects dealing with sustainable tourism and mobility. Regarding his role within the climate services value chain, he mainly acts as a purveyor of climate information. For his consulting activities he uses publicly available climate data and information and in some cases data from NMS or universities. Usually he uses climate data that is free of charge.

The interviewed CEO from a national park, initially contacted due to his supposed role as potential CS user, sees his organization more as a CS provider than a user as it operates climate stations in the national park and does research on climate change impacts on flora and fauna. Users of the data are other researchers and tourists.

4.2.2 Perceived barriers to the use and provision of CS

Barriers to the use of CS

The interviewed CS providers see the major barriers to using CS in the lack of risk awareness, the short planning horizon of tourism businesses and the uncertainties of (climate) forecasts and projections.

A tourism consultant believes that risk awareness in the tourism sector is quite diverging and highly dependent on individuals. According to another interviewee, it seems to be a matter of generations, i.e. younger CEOs tend to be more interested in sustainable tourism and CC topics. In regard to awareness-raising, a CS provider indicates that not only climate change impacts on tourism have to be better communicated, but also the responsibility of the tourism sector in climate change mitigation (travel mode, energy use, food consumption, etc.). He refers to already existing good practice examples (e.g. "Alpine Pearls").

The short planning horizon of most tourism corporations, which only comprises 5-10 years or less, is identified by several interviewed providers as a major barrier in using CS. Tourism businesses are not yet concerned about climate change; they are not yet under pressure to take actions. Short-term weather services and seasonal forecasts are perceived as more important than services concerning the long run. One interviewee states that the main barrier of using CS is that these services do not seem to be actually needed, except for decisions on large investments (lift infrastructure, buildings etc.). According to the interviewee, the climate community tends to overestimate the importance of climate (change) in decision making processes. "Climate is an important factor, but compared to all other influencing factors, the relative degree of importance is often less than 10 %, especially in tourism".

The uncertainty of climate projections is mentioned several times as an obstacle in using CS. Practitioners often do not know how to interpret and deal with these uncertainties. One researcher believes that the communication of uncertainties is the biggest challenge. Customers lose trust in scientific studies and CS if uncertainties are not communicated adequately and measures are taken on the basis of study results which turn out to be incorrect. Generally, the understandability of CS is seen as another barrier. Results are often presented in a form that is too difficult to understand for practitioners.

The lack of suitability with regard to the spatial resolution of information is noticed as a further obstacle in using CS, as people would be more willing to take actions if regionalized information for their respective tourism destination was available.

The interviewed researchers experienced also that the period of delivery is a potential barrier in using CS. Customers from the corporate world tend to request particular information on short notice and the CS needs to be provided within a relatively short time period (a couple of months). This often contradicts the practices and procedures common within the scientific community.

It is also mentioned that CS are not used because people often do not know where to find reliable information and services.

Barriers to CS provision

One of the major barriers to providing CS is seen in the costs of meteorological data that are often needed as input for climate services. The NMS in Austria (ZAMG) as primary provider of meteorological data is financed by public sources, but only partly. Hence, it has to act market-based and charges fees for the (commercial) use of their data – for scientific purposes it is usually free of charge (apart from the

compensation of the processing costs). According to an interviewed provider, the costs for these meteorological data particularly represent a barrier in the case of pilot projects and product development, where for testing purposes the data requirements often comprise several parameters, various locations, high temporal resolutions and long-term horizons. Prices for such data volumes are in the five-digit Euro range, which often makes them unaffordable in the product development phase. The interviewed provider also sees a competitive advantage of the NMS in providing CS compared to providers who have to purchase their (partly) publicly financed meteorological input data, although the NMS has to allocate costs internally when using these publicly financed data as input for commercial products. Furthermore, one interviewee believes that currently the CS market is still too scientifically driven. More marketing experts, sales experts, communication experts and graphic designers should be included in the development of CS.

The dependency on data provision by customers is another major barrier in providing CS. Some services need user-specific data as additional input. This might be data on sales, profits, visitor numbers, energy consumption, snowmaking capacities, etc. Receiving this kind of information is particularly difficult if the service is not directly commissioned by the businesses under consideration but provided in the course of a funded research project or commissioned by an interest group. An interviewee identifies two reasons for the little interest of ski resorts (and other businesses) to participate in national and international research projects: on the one hand they are afraid of negative publicity if identified as little snow reliable and on the other hand they do not want to share sensible business data.

For an interviewed hydrologist the (shared) property rights of models which have been developed at different universities could be one obstacle to exploit them on a commercial basis. Another statement by an interviewed provider regards the level of detail customers often wish for models and services, which cannot always be fully accomplished (e.g. with regard to the spatial resolution, accuracy of forecasts/projections etc.). A similar response is given by another interviewee, who sees barriers or challenges in providing CS with respect to the required spatial resolution, and moreover, in the coupling of models at different resolutions (e.g. applications of urban micro-climate models).

For summer tourism the interviewees from the scientific community feel that more research is needed in order to be able to provide particular CS. Generally, the potential for CS regarding summer tourism is perceived as rather small by the interviewed providers.

Table 11 summarizes the barriers to the use and provision of CS as perceived by CS providers.

TABLE 11: PERCEIVED BARRIERS TO THE USE AND PROVISION OF CS

	Type of barrier	Perceived barriers
Use	*Awareness*	– Lack of risk awareness, in particular among the "old generation" of ski lift operators – Sources for information unknown – Missing conviction on the benefits of using CS
	Priorities	– Short planning horizon of tourism businesses – Weather services and seasonal forecasts more relevant – Importance of climate in decision processes overestimated (by climate community)
	Applicability	– Understandability and suitability of CS
	Lack of trust	– Uncertainties of projections

Provision	*Economic*	– Costs of meteorological input data
	Technical/ scientific	– Limited data provision by users – Property rights of models/data developed in funded research projects at different universities – Spatial resolution & model coupling – Summer tourism: more research needed
	Organizational	– CS market too scientifically driven

4.2.3 Uncertainties, standardization and quality assurance

Uncertainties

The interviewed CS providers account for and communicate climate modelling uncertainties by using and presenting a range of climate scenarios. One interviewee emphasizes that he clearly differentiates between uncertainties that arise from climate modelling and uncertainties of human behavior in the future. However, he also refers to the fact that people could be confused by the extent of uncertainty that is communicated. He proposes reducing the communication of uncertainties to two/three possible development paths. Moreover, he suggests bringing the CC uncertainties in relation to other uncertainties which people are often not aware of (e.g. budget plans in politics). In general, the communication of uncertainties is seen to depend on the use case. In case of high investments, uncertainties are more relevant to be considered than e.g. in case of general strategic planning (without high investments) which can still be corrected in the short-run.

Another way of presenting future impacts is to show the impacts of global warming in +0.5°C or +1 °C steps, i.e. an "if-then" interpretation of results.

Standardization and quality assurance

Standardization of CS is quite difficult, particularly for tailored services that are not limited to climate data use, i.e. climate inclusive consulting services. Standardization seems to be less essential for tourism from a user perspective, but it is usually important for CS suppliers. Certain standards should be defined for cost-efficiency reasons, compatibility, comparability, and transparency.

Since it is difficult to measure quality and to define standards, most interviewees see the (scientific) reputation of CS providers as a criterion of quality. Commissioned studies and services are usually not reviewed and evaluated, but researchers refer to the fact that the applied methodologies and models are mostly developed in research projects and published in peer-reviewed journals. Hence, they regard the application of methodologies that have passed an evaluation process as one quality criterion for CS.

In general, the quality of a service depends on the quality of the input data, e.g. the quality of meteorological measurement data, the quality and level of detail of business data, etc. As one snow modeler states: "*The more input data the better the snow modeling*".

Another part of quality assurance perceived as important is an adequate communication of how to use climate data correctly. This is especially important if a climate service is the result of a modelling chain that involves several providers and intermediaries. In this case, intermediary users of climate data need detailed information and guidance on how to use the data correctly. According to the experience of an interviewee, this information exchange works quite well in small research projects but it represents a much

bigger challenge in large projects with many partners. Trainings for a proper use of climate data and certifications have been discussed in this context.

One of the interviewed climate researchers believes that the quality of a CS can be measured by its influence on decision making, i.e. whether the service is used and perfectly matches user needs, whether it is easy to understand and whether actions are taken based on the provided information. According to this interviewee, a product could be defined as good if it is selling well.

4.2.4 General issues and recommendations

According to one CS provider, the success of a CS is highly dependent on the person selling the service ("50 % the person, 50 % the product itself"). He regards communication and sales skills as well as the personal contacts to customers as very important. A foundation of trust has to be built between CS provider and customers. Hence, sales experts are needed to successfully sell CS and to expand the CS market. "It is easier to teach a sales person climate basics as vice versa".

Personal contacts as a key to success are also mentioned by another interviewed CS provider. He suggests participating in sector-specific events, holding presentations, "*being present as a player in the field*". Furthermore, "*it is important to speak the language of the customers and to understand their needs*". At the same time, the scientific language needs to be simplified so that lay persons can understand the facts. Overall, awareness-raising is perceived as very important. The CS providers experience that the young generation is more open-minded, i.e. younger people are more interested in using CS.

One interviewee refers to the concept of "service design" by Météo-France as a good example for developing CS. Climate scientists work together with end-users and a service designer. The designer's role is to propose an innovative approach based on the interaction between providers and end-users. The designer looks for a consensus between the scientific possibilities and the users' requirements, taking their expectations and references into account (Corre *et al*. 2015).

The existing platforms of CS providers (e.g. http://www.climate-knowledge-hub.org/, http://kompetenzlandkarte.ccca.ac.at/) are suggested to be linked to climate databases and publication lists so that users can easily inform themselves about existing publications and available data sets. The success of climate databases such as the CCCA Data Centre in Austria (https://data.ccca.ac.at), however depends on the commitment of climate scientists to provide data for general use.

Furthermore, a forum for CS providers to find partners for projects and product development is considered as helpful. The same holds true for a platform where CS users could express their needs, i.e. where they could upload a request for a CS that would automatically be sent to qualified providers (based on a keyword search).

Consultancy is perceived as very important by the interviewed CS providers as well. The interviewed tourism consultant believes that the demand for CS will increase in the future as the pressure increases. Including CS into common tourism consulting services would be most promising. Overall, the integration of climate information into products and services already in use by the tourism industry is seen as a promising driver for CS take-up. One of the interviewees hence regards the attempt of CS providers to get directly in touch with the end-user, i.e. the tourism business, as a common mistake. He rather recommends addressing those players regularly in contact with and trusted by tourism businesses due to their offered products and services, e.g. producers of snow cannons in the case of ski resorts as targeted

end-users. This is also one of the strategies followed by the ongoing H2020 project PROSNOW that is developing a demonstrator of a decision-making service for snow management in ski resorts (see chapter [2.4]). The project includes several providers of snow production, monitoring and management systems in its consortium in order to design the planned meteorological and forecasting service in a manner easily integrable into products already in use by ski resorts.

Concerning research needs, changes in travel behavior, demographic changes and changes in tourism demand are mentioned as topics that could be more important to some types of tourism businesses than pure climate data.

4.3 Workshop results

4.3.1 'Triggering problems' as motives for users to find interest in CS

In the following we summarize prior findings from the interviews and additional findings from the workshop regarding barriers, user needs, and triggering problems as motives for users to find interest in CS. 'Problems' here means reasons, impulses, motives to act. 'Triggering problems' means issues that lead actors to considering or using CS. This angle of analysis addresses user demand in practical terms: what are the questions for which CS could possibly or is expected to provide answers? The following consideration, voiced by participating stakeholders, may be a good example to illustrate typical climate-related rationale in tourism: For mid-/long-term tourism strategy the following question is of essence: How long will skiing operations still be possible, on which winter tourism depends in most areas (or will it be necessary to close all skiing slopes below 1.500 meters within the next 20 years)?

User needs, as mentioned by the stakeholders present, are associated with a variety of use cases for which problem issues are reoccurring. Table 12 sorts the problem issues along different use cases.

TABLE 12: SUMMARIZED USER NEEDS - USE CASES AND PROPLEM ISSUES

User needs		
Use cases	***Type of needs***	**Problem issues**
Tourism associations/ hospitality	*Monitoring/ Historical*	– Guest monitoring – analysis of tourist flows and prevailing weather conditions
	Short-term	– App for activity recommendations based on weather forecast as a service offer for tourists (already in use by some institutions) – Short-term weather-based packing lists as a service offer for tourists
Ski tourism	*Communication*	– Communication/Promotion of already open ski resorts particularly in case of lacking "winter feeling" in urban areas (i.e. warm and snow free conditions)
	Short-term	– Improving demand forecast accuracy: related to factors not alone linked to weather; linked to degree of slope opening at the beginning/end of a season; linked to weather transitions periods – Personnel deployment planning for parking and cash desk at lift stations – Meal preparation planning for restaurants at lift stations
	Strategic	– Improving climate and snow modelling: foehn events, extreme precipitation, water flow rates in pipes

		– Estimations about how much snow/days lost each of the next five seasons will bring – Highly resolved wind simulations for planning purposes (ski lifts, snow fences for natural snow depots, etc.)
	Research	– Market research about demand in relation to climate (change), e.g. importance of natural snow, backyard effect (e.g. importance of snow situation in city for decision to get on a trip to the mountains for skiing)
Bicycle tourism	*Strategic*	– Climatological conditions under which outdoor cycling in hot summers is still/no longer experienced as enjoyable
Federal state administration of tourism affairs	*Strategic*	– Analysis of bathing conditions and investments planning, advice on adaptation strategies; e.g. do investments in bath resorts still make sense in face of climate change (risk of drained lakes)? Should hotels better invest in additional swimming pools? – Investments planning for cycling infrastructure
Urban ecology	*Strategic*	– Climatological planning of places; what measures support that people like staying at an urban space; including building materials, green areas/trees/plants, roofs, water areas ("making a place climate proof")
Tourism in general	*Applicability & Format*	– Climate change impacts and adaptation strategies at local/regional level (high spatial resolution) – Compact preparation of main results and conclusions; consultancy services most relevant
	Short-term	– Improving weather forecasts (and seasonal forecasts)
	Research	– Market research about demand in relation to climate (change), changes in travel behavior, general trends in tourism and leisure activities, demographic changes – More research on impacts on summer and shoulder-season tourism – Research on climate change impacts on ecology and agriculture and implications for tourism

At the level of tourism associations, it is rather not climate, but weather concerns that are already subject to seeking meteorological advice. Weather apps are already being used for this purpose. Skiing tourism, by contrast, is eager to combine both short-term weather and mid-/long-term climate expertise, and some pioneering actors are investing into quite detailed, high-resolution analysis. These are supposed to answer specific questions related to management planning (staff, infrastructure, investment). While CS can help here and are experienced as quite reliable, CS could still be refined (e.g. demand forecast accuracy). Improvement would often mean to thoroughly integrate climate with other economic, consumer behavior, and logistic aspects. In similar ways, just obviously with slightly less complex infrastructure problems compared to skiing, bicycle tourism also enjoys expertise on changing conditions for outdoor cycling and implications for business, policy, and planning. On state/administration level, CS has become interesting as basis for strategic recommendations in regions for a whole array of businesses depending on tourism (hotel investments into outdoor vs. indoor facilities, for instance; or again cycling infrastructure). CS is also used in planning of urban tourist spaces. Finally, there were some more generic issues mentioned for tourism, such as the need for combining climate and market prospects and the interlinkages between ecology, agriculture, and climate from a tourism perspective (although the latter may also be

useful e.g. for farmers, who sometimes even combine farming, food production and tourism in their businesses). Since local/regional tourism associations (as intermediaries between tourists, public bodies, and business) often see themselves rather as individual competitors than as potential partners to a certain extent, it could be hard to benefit from scale effects in purchasing CS together.

In addition to the articulation of demand, it is also important to see the obstacles for a better matching of demand and supply in CS.

Table 13 categorises the types of barriers and the problem issues related to a type.

TABLE 13: SUMMARIZED BARRIERS BY TYPE

Barriers	
Types	**Problem issues**
Priorities	– Lacking economic pressure/degree of suffering not high enough: business managers choose other priorities over looking into climate issues – Responsibility for action shifted to others – When not directly heavily dependent on snow, climate as an issue and CS as support not considered relevant in tourism regions – Lack of long-term risk management: planning horizon 5 years ahead at maximum; higher interest in weather services and seasonal forecasts – Addressing climate risks is a complex issue that requires resources outside of one's daily business: prioritization of tasks – Urban tourism: weather intelligence usually only requested for bigger events, not for routine events – Trade-offs between economy and ecology: Reluctance to look into climate issues because (winter) tourism has a legitimation issue with regards to environmental damage it may cause. Public discourse shifts as nowadays skiing slopes and lifts are increasingly called into question.
Costs	– Addressing climate risks is a complex issue that requires resources outside of one's daily business: limited resources e.g. for data preparation by users – Financial constraints – CS provision – high costs for meteorological input data – CS provision – property rights of models
Applicability	– Applicability/spatial resolution – Lacking user-friendliness of CS (scientific language)
Uncertainty / Lack of trust	– Uncertainty of climate scenarios – Conflicting messages in the media
Awareness	– Lack of risk awareness – Unawareness of CS providers, offered CS, and CS benefits

The barriers mentioned by interviewees and stakeholders during the workshop in Graz refer, firstly, to priorities according to which (potential) users of CS make a decision whether or not to seek strategic intelligence about climate-related problems. Several reasons are given that influence the prioritization of

CS on a higher or lower scale, such as a sense of urgency (pressure, responsibility), size of the event or business for which targeted CS could be ordered, the absence of risk management related to climate issues, or the perception of a trade-off between the ecological and economic implications of looking into climate issue to the disadvantage of CS considerations. Secondly, and certainly related to priority setting, is the question of costs: here, stakeholders often feel unable to justify the necessary investment in CS. Thirdly, CS in their view is too often not easily applicable. Fourthly, there is only limited trust in the necessity and urgency for climate considerations. Finally, in tourism there is a broader spectrum of actors either not aware of any risk from climate change for their business, or not aware of CS and their benefits, as well as about access to it.

The workshop participants and interview partners also mentioned some more general observations about problems climate service providers have in matching demand and supply sides, which are summarized in Table 14.

TABLE 14: GENERAL OBSERVATIONS REGARDING CS MATCHING

Category	Problem issues
Communication & visibility	– Better communication of scientific results, CS and CS providers – A newsletter including the latest findings would be helpful – Demonstration of benefits of CS / best-practice examples – One institution that could be trusted to provide credible information – Forum for CS providers to find project partners and for users to express their needs (uploading a request).
Diversification of CS providers	– Currently, CS are mainly provided by research institutions alongside to their research – Too little emphasis is put on product development and design, sales and marketing as well as consulting activities – Room for CS intermediaries
Integration in broader set of relevant consultancies	– Integrating CS into common tourism consultancy services – Towards a broader tourism strategy when faced with climate change effects
Bandwagon effect	– Climatological analysis regarding snowmaking infrastructure for resorts leads to demand for similar analyses from others (through federal state administration)
From weather to climate	– The use of weather services as a potential driver for prospective use of CS

First of all, CS seems too scientific for many (potential) users, according to those participating in the workshop. At the same time, it could help CS if the economic benefits of CS were be better demonstrated (or even made explicit, in the first instance, instead of assuming users would easily calculate that themselves). Communication of what CS can do for tourism would also need to be built on trust: an institution offering CS would have to build trust – perhaps over a period of time – until they would become real partners for tourism.

However, positive climate effects are seldom mentioned, such as urban exodus and increased mountain tourism in summer due to summer overheating. At the same time, if there is interest in CS, but cannot be satisfied bilaterally, there should be a sort of forum for finding project partners (be it among providers or users). Besides that, there is a feeling that CS providers are rather diverse. Intermediaries would make it easier for users to navigate through the offers and to learn what could be beneficial for them specifically. Another aspect related to building bridges seems for stakeholders to better integrate CS into a broader consultancy that tourism typically makes use of. With respect to how the added value of CS is demonstrated, providers could show good practice examples of projects that proved to have added value for tourism.

Finally, and in the same vein, plausible linking of weather and climate services could increase readiness for and attractiveness of CS. Stakeholders also said relying too much on short-term weather forecasts could be risky, since tourists tend to cancel stays when bad weather is expected instead of coming to terms with any weather. For tourism areas, it would be good to have an overarching strategy in light of climate change effects that makes them attractive however the weather there is.

4.3.2 Discussion of the CTA scenarios on climate services

What we call a "CS typology", is in fact an empirically informed heuristic with the purpose of showing different alternatives that could take shape in the further development of CS user-provider relations. It has been used throughout the project to stimulate stakeholder dialogue about more specific formats of CS (the four CTA scenarios; see section 3.1.2), while not only remaining at the level of simple examples. The typology implies a set of criteria that allow for closer inspection of structures of demand and of services relationships with users in their contexts, but also among providers. In Graz, in the main focus of the stakeholders was the question how the four principle formats would actually help CS users. Participants found that this discussion did indeed reveal some crucial insights about demands and barriers for developing CS.

4.3.2.1 MAPS & APPS

This type has been introduced to the discussion as the way of using CS by users accessing climate data themselves in contrast to 'sharing practices', where users offer mutual exchange about climate-related issues in a given context of use. It contains what is provided by the maps & app services. It may be based on open source data, but it could also be an app provided on the basis of a contract with a specific CS provider. Users are knowledgeable enough to be able to use the CS provided via the maps or apps. When questions arise, the provider may help, even with more specific guidance, but most likely for an extra fee.

MUCH FOR LITTLE ATTITUDE: Many ski lift managers want simple answers, ski lift managers said during the discussion. They want integrated consulting for the price of a simple app. A maps & apps approach seems very desirable to clients, who would certainly like to expect to get everything by pressing a button – but in reality, what they really need, is integrated consultancy with some degree of expert advice. Weather apps for free are blamed for not being reliable, but in fact they cannot expect more from an automated punctual prognosis where no human expert interprets and revises the information available. Weather prognostics at airports, by contrast, are highly personnel intensive and tailor-made by experts around the clock. According to a ski lift operator, a tailored weather forecast for skiing on three levels of altitude would cost 250 Euros, but people expect a free app can do it. – The question remains whether an app could also lead to a more tailored service when the app is used as a tool to communicate a

request to the CS provider, to gather on the spot data, and linked to a subscription model e.g. for expert advice. Users would use it to order and receive 'strategic intelligence' via the app. They would access tailored services for which they already paid – wherever they are and whenever, since the app would be on a mobile device.

WHO CAN OFFER MAPS & APPS: Another question raised during discussion was whether a small CS company has capacities to build or buy and maintain such a service. – It is still open whether basic app & map level CS infrastructure and applications could also be provided by an umbrella organisation or meta-service provider (offering maps & apps for smaller CS providers with typical or specific functions, depending on the business model; think of online banking infrastructure provided by meta-providers for the entire group of individual banks). Participants discussed that tourism associations (in which local and regional offices are represented) could order and then sell an app to their members (like excursion destinations, accommodation services, sports parks) and thus refinance the CS.

4.3.2.2 SHARING PRACTICES

'Sharing practices' describes the type of CS where users offer mutual exchange about climate-related issues in a given context of use. It contains what is shared by the community. It can be thought of as a smaller or larger platform. It is like a forum of interested parties sharing experiences and other information, perhaps also the experience of using CS. One example is the Facebook group in Helsinki where people linked to municipal agencies, NGOs, and even some engaged experts and consultants meet and exchange about climate issues. It may in most cases be based on open source data. Users are knowledgeable enough to be able to use the CS provided via the forum. When questions arise, the community can help, one may even get specific guidance.

OPEN FORA NOT EVERYWHERE IN USE: This model is rather common in scientific and professional communities, as well as in general interest social media networks and in topic specific social media groups. Climatologists and meteorologists are in constant exchange anyway, also internationally.

THE ROLE OF BUSINESS ASSOCIATIONS: Obligatory membership in business associations (e.g. ropeways association) supports exchange, and a younger generation of managers is willing to go the extra mile for discussing and testing innovative means of creating input for decision-making, such as using CS. Exchange among tourism associations happens only occasionally. The responsibility of sharing information is seen at higher level (provincial or national tourism associations).

COMPETITION AND COOPERATION: Limits of exchange in business are often reached when strategic advantages over competitors shall be used as well as when other issues have higher priority. Cooperation still can make sense when e.g. sharing costs for basic analyses, while individually buying more specific strategic advice in addition.

HOW BROAD THE COMMUNITY: Another open question is whether 'sharing practices' better work in narrower local networks or broader contexts. However, how broad or narrow the context is, the participants agreed that it all depends on whether the climate is considered an issue at all. If not, then there would hardly be sharing of experiences and information, let alone any willingness to pay for more tailored products.

SHARING EXPERIENCE FOSTERS ACCESSABILITY: When there is interest in CS, which cannot be satisfied directly (because users might not know what they can get from whom), a forum for finding project partners (be it among providers or users) could be useful.

4.3.2.3 EXPERT ANALYSIS

Expert analysis would typically answer a more specific request for knowledge or advice, but the answer would not cover the entire process of practical application of the expertise in the business context.

NEED TO UNDERSTAND COMPLEX DETAILS: For winter tourism, e.g. from a lift operator perspective, most issues need detailed expert analysis, and then need to be brought together under a climate-inclusive consulting (CIC) approach that links and integrates more specific expertise.

INTERMEDIARIES AS KNOWLEDGE BROKERS and facilitators for matching demand and supply of CS expertise would be important since they are able to engage into more sophisticated and prolonged development of suitable CS formats and business models. The example mentioned here is the Snow Center Tyrol (Schneezentrum Tirol). Business associations by contrast would sooner or later have their limits regarding the time they can invest besides running the daily businesses or regarding the level of professionalization they can use in order to care about more than just the main business, such as risk management in a broader sense, including climate considerations.

LIMITATIONS TO FORECASTING: The topographical and climatological complexities of certain areas, such as the Austrian mountain region with several interfering climate zones, suggest that not everything that a user could wish from CS would be feasible. Seasonal forecasts in Austria are extremely difficult, if not impossible for the time being, said meteorologists. Big coordinated research effort would be necessary to change the situation.

4.3.2.4 CLIMATE-INCLUSIVE CONSULTING

The 'climate-inclusive consulting scenario' stands for a customised climate service integrated in a broader consulting service. Service would be provided by public or commercial organizations that integrate local climate data and analyses into their services. Cross-disciplinary commercial firms would deliver tailored climate advice, based on what public meteorological institutes and universities deliver as meta-services (measuring, modelling). Data infrastructure would have to be moderately homogeneous and rooting in a dense, locally adapted measuring grid. User-oriented cross-disciplinary consulting engineers would create value by using climate knowledge that is integrated with other knowledge (e.g., geology, civil engineering, sociology). Government could support climate knowledge development in established consulting and engineering firms.

INTEGRATION: It was quite clear that the integration of CS into the broader spectrum of issues for which consultancy in tourism typically makes use of, would help linking climate-aspects meaningfully to other decisive questions for business management, be it on the planning level (e.g. season, further development of the season, investments over the next 5-10 years) or daily management level (e.g. current resource allocation).

SERVICE FORMATS CAN BE LINKED: CIC requires often expert analysis to some extent, making sure enough climatological expertise goes into advice. Austrian meteorological institutions (e.g. ZAMG) giving strategic advice to federal state bodies work on the basis of a combination of expert analysis and CIC. The same is true for a smaller company like Weatherpark and for a public company like Joanneum Research.

At the end of the workshop the participants were asked to rate the four types of CS relations. Highest were expert analysis and climate-inclusive consulting. Those stakeholders who had prior experience with CS would rather trust their ability to work also with very specific advice, whereas new or not-yet CS users

would prefer the all-inclusive package, by which they were also told how to make sense of CS in the context of their broader business decisions. The same pattern was found at the workshop in Helsinki with stakeholders from urban planning (see Giordano *et al*. 2017).

4.3.3 Value Proposition Canvas

In the following the results of the two working groups using the Value Proposition Canvas (see section 3.1.2) are summed up.

Tourism associations

Thinking about their jobs to be done and the pains they face, the head of a local tourism association indicated that tourism associations mostly suffer from their in-between position: On the one hand, tourism associations have to be directly available for customers (tourists), provide information and ensure customer satisfaction; on the other hand, they have to be available for their members (tourism service providers) – who pay for the membership – to fulfil their needs and expectations. This is challenging, in particular because the product and service quality of tourism service providers is not always satisfactory and tourism associations do not have any regulatory power.

Based on the analysis of the customer side the group tried to think about concrete improvements to support the daily business of tourism associations. A new idea which came out of this discussion was to think about a quality measuring tool or system to make sure that the provided services accomplish the expected and promised quality. Also, to think about new or improved customer feedback tools can be an approach to gain valid feedback to adjust the service or product.

One crucial pain that was identified is the lack of time and capacity to develop and establish new ideas, which also hampers the development and use of CS by tourism organizations. However, regional development – further development of existing products and services as well as the creation of new ones – is seen as one of the most important gains for a tourism association. In general, the necessity of an integrated, holistic planning process, which also includes climate change issues, was discussed. This process also requires a detailed budgeting and prioritization of tasks.

Another idea developed during the discussion is for example a short-term, weather-based packing list for tourists before they start their trip. Also, a weather-based activity recommendations tool could be useful which suggests weather specific sightseeing spots. This, however, requires improved weather forecasts and also raised questions about financing the tool and the associated right to be listed in the activity recommendations. A kind of guest monitoring, an analysis of tourist flows and prevailing weather conditions for a tourism region was also mentioned as an opportunity to support short-term planning and peak demand management.

Another topic was dynamic, weather-dependent pricing to avoid bad weather cancellations. This was also part of discussion in the ski resorts working group. A ski resort operator indicated, though, that skiing demand is quite price inelastic and that is why dynamic pricing has not been considered yet in his ski resort.

Summed up it would be a great improvement to work closer together with all different kinds of suppliers in the tourism sector to create synergies.

Ski resorts

The jobs to be done for a ski lift operator are on the first glimpse clear, but the value proposition canvas tool helped to be more specific and to see the single steps and details. The most important job for a ski lift operator is the provision of an optimal snow cover, including snow production and grooming, but also avalanche protection, wind protection of ropeways, etc. This leads to the need of a good snow and data management. Further tasks relate to guest information e.g. about snow conditions and open ski lifts and activities in the summer period, like pasture management and constructional adjustments of ski slopes. And in the end, the tourist needs to be happy to come again, because he/she is the end-user and paying customer of this market segment. Also here, a good customer feedback tool can help to gain the right and valid feedback.

In society, the awareness of eco-tourism has been rising and thus also the carbon footprint of a ski resort and skiing holidays gains more importance. Measuring the carbon and ecological footprint of ski tourism is challenging and to use it as an argument has to be done with caution. Ideas to use green electricity or to include an environmental tax in the ticket price were discussed.

Ski resorts are highly weather dependent, as the meteorological conditions not only influence the service provision (natural snow availability and snow production), but also skiing operations and skiing demand (snow/wind storms, cold temperatures, cloudiness). Hence, accurate weather forecast data is very useful for the operational business and short-term planning. Concerning short-term weather forecasts, the idea came up to use a ski resort's own weather measurement data (of weather stations mostly integrated in snowmaking facilities), which is often available for different altitude levels, to provide the ski resort with improved and tailored weather forecasts. Reliable seasonal forecasts could be useful for an optimized snow production planning, but for a region like the Alps seasonal forecasting is still quite difficult because of quick weather transitions. Snow production planning is thus quite challenging. The ongoing H2020 project PROSNOW (http://prosnow.org/) addresses this topic and uses local meteorological data provided by the ski resorts (including local snow depth recordings from grooming machines) for downscaling and initializing the forecast model.

For both groups fluctuations in the occupancy was mentioned as a pain. Business development toward all-season tourism is perceived as important for both user groups.

Table 15 gives an overview of the identified pains and user needs for the two user groups. The entire value proposition canvases that were filled during the workshop by the two groups can be found in Annex D (translated from German to English).

TABLE 15: USER PAINS & NEEDS

	Type	Problem issues
Tourism associations		
Pains	Priorities	– In-between position, intermediate between customers' expectations and tourism service providers – Responsibility for taking action in climate issues not clear (among different administration levels)
	Quality	– Low product/service quality of some members (tourism service providers) – Responsibility for quality assurance, but without regulatory power among members (tourism service providers)

	Capacity/ Resources	– Lack of time and (financial) capacity to develop and establish new ideas
	Other	– High seasonal fluctuations in the occupancy
Needs	Strategic	– Holistic planning process – including climate issues (requires detailed budgeting and prioritization of tasks) – Increased exchange (of knowledge, experience, etc.) between tourism associations – Digitalization
	Short-term	– Short-term weather-based packing lists as a service offer for tourists – Weather-based activity recommendations as a service offer for tourists – Improved weather forecasts – Peak demand management – Weather-dependent, dynamic pricing
	Monitoring	– Guest monitoring – analysis of tourist flows and prevailing weather conditions – Improved customer feedback (as a quality measuring system)
Ski tourism		
Pains	Quality	– Poor slope conditions / snow conditions (foehn events, extreme precipitation, water availability)
	Other	– Fluctuations in the occupancy
Needs	Strategic	– Highly resolved wind simulations for planning purposes (ski lifts, snow fences for natural snow depots, etc.) – Strategies for all-season tourism
	Short-term	– Good snow and data management – Improved weather forecasts
	Applicability	– High spatial resolution

4.3.4 Further issues observed

Participants suggested further analyses and CS product creation could focus more than before on alternative CS foci, such as CS for mountain areas (which would not concern tourism alone, but also farmers, climbers, etc.), traffic infrastructure or CS for cities (not to be reduced to urban planning).

It has also been suggested to bring more actors that would contribute to a more realistic set of perspectives:

- Big consulting firms that are already partially using climate intelligence
- Hotel owners, restaurant owners
- ÖBB, public transport bodies and private transport companies
- Insurances
- Politics
- Pioneering regions sharing experiences
- Municipalities
- Market/trend research firms
- Citizens
- (Winter/summer) tourism equipment manufacturers

The project has tried to include some of them. However, the fact that they did not accept the invitation to participate in the workshop does not necessarily mean that CS are entirely irrelevant to them. Perhaps finding out how to engage them or how they already are engaged in their ways would teach key lessons about matching CS demand and supply also for these actors.

4.4 Complementary interviews

CS demand – tourism associations

The follow-up interview with the head of a local tourism association in Upper Styria – she also attended the workshop – underlines that the use of CS in the tourism sector may be more of a concern for tourism service providers with high investment needs in infrastructure and high vulnerability (e.g. ski lift operators). Tourism associations (and other interest groups, like the chamber of commerce) may act as knowledge brokers and could take the initiative for promoting joint acquisition options. According to the interviewee, tourism service providers would not cooperate on their own, at least not the hospitality and gastronomy sector. If any, then only a leading tourism service provider of a tourism destination probably could initiate joint acquisition of a product or service. Hence, joint acquisition should be organized through umbrella organizations and interest groups. In case of tourism associations, the responsibility lies at the intermediate level, i.e. regional tourism associations, which coordinate the activities of local tourism associations and are responsible for regional development and infrastructure. Provincial tourism associations are primarily marketing organizations.

For tourism associations pure climate information and indicators (e.g. number of hot days, index indicating good weather for swimming) are not relevant. It has to be translated into actions and adaptation strategies. Nevertheless, the interest in CS still seems to be rather low. Tourism trend cycles range between 5 to 7 years. Hence, it is difficult to take measures for the next 20 years due to the higher uncertainty of general tourism market trends.

Regarding short-term services, the interviewed tourism association expressed the highest interest in the weather-based activity recommendations tool. The weather-based packing list, which was brought up in the workshop, is a nice idea and add-on for guests, but the willingness to pay for it is rather small, because it neither influences the number of arrivals nor the length of stay (which is the main motivation for tourism stakeholders to invest in services). A weather-based guest monitoring tool for peak demand management could be of interest, but only for large tourism regions, where overrun tourist attractions is an issue.

Monitoring fact sheets (on a seasonal basis) analyzing past performance of a tourism region in relation to prevailing weather conditions could raise the awareness for climate issues. Here, the responsibility is seen at the provincial level.

CS provision – communication & visibility

The interviews showed that tourism businesses are often not aware of existing CS or CS providers and where to find reliable information. In addition, the wish came up to have one institution that could be trusted to provide credible information. We discussed these issues with the CCCA, the climate research network in Austria, which is a contact point for researchers, politicians, the media, and the public for all questions concerning climate research in Austria. The institution seems not to be widely known among private end-users. Hence, the visibility of the CCCA in particular among private companies and

organizations as a contact point and knowledge broker needs to be enhanced. This, however, requires additional resources.

The idea of expanding the existing CCCA 'Kompetenzlandkarte', an initiative to map climate researchers and their expertise, in a way that CS providers have the opportunity to promote their CS by including a short description and examples of their service attracted interest and the technical implementation will be discussed internally. Nevertheless, the success of this platform depends on the willingness of CS providers to add and demonstrate their service.

CS provision – cooperation

As mentioned in section 4.2.2, the costs of meteorological data that is often required as input for CS development are perceived as one of the major barriers to providing CS. Hence, besides the need for innovative (cost) sharing models on the user side (i.e. joint acquisition of CS) there also seems to be a need for an increased use of cooperation models on the supply side of CS (unless this input data is provided by public funding). This need for cooperation models on the supply side is reinforced by the fact that the development and provision of CS is usually a highly interdisciplinary task and often requires the involvement of a number of actors (see Köberl et al. 2018 for an illustrative example). Thus, we discussed the topic of cooperation models with a project coordinator of the NMS to explore existing and potential options for cooperation between climate data providers and re-users – or more generally for cooperation along the value chain of CS provision.

Some background information: The NMS in Austria is a subunit of the Federal Ministry of Science, Research and Economy. Since 1990 it has the opportunity to act under private law within its partial legal capacity. Hence, the NMS in Austria consists of a public and a semi-public/private part. Products and services which are provided in the course of their legal mandate are free of charge. Products and services beyond this legal mandate are charged with prices that depend on the purpose of use (i.e. scientific vs. commercial use; end-user vs. reseller etc.). Whereas data for purely scientific purposes is usually free of charge (apart from the compensation of the processing costs), data used commercially has to be paid for. For the purpose of product development, the NMS allows discounts on data prices. Once the product enters the market, the differential amount on the full price is to be paid back e.g. in rates or through profit shares. It has to be mentioned that in their semi-public/private form the NMS also pays for its data in order to not allow for a market distortion. In addition, there is the possibility for individual agreements and cooperation models, which was the main topic of the follow-up meeting with the project coordinator of the NMS. What follows is a summary of the discussed existing and potential cooperation models, which are of general relevance for cooperation along the value chain of CS provision.

- *Turnover/profit sharing instead of a fixed data price:*
  Sharing a product's/service's turnovers or profits between the involved institutions (e.g. in proportion to the work effort) instead of charging a fixed price for upstream (data) inputs could be a promising alternative to overcome the barrier of high input data costs preventing CS development. For the downstream party it also represents some sort of risk sharing (product development always bears some risks as the developed product or service may fail on the market).
- *Joint product development:*
  Joint product development and provision is similar to turnover/profit sharing, but goes a step further as the upstream party is more actively involved.

- *Mutual forwarding and mutual promotion:*
  In case of products or services that are complementary to each other the cooperating institutions may use their existing channels for co-promoting and distributing them. Austria's NMS, for instance, provides various tourism-related products, such as "Slope-weather", "Holiday-weather" or "Sail-weather". For cooperating CS providers they offer to promote downstream or complementary climate services along with their own products. In addition, product and service requests not dealt with by the requested institution but falling into the other institution's area of expertise could be mutually forwarded. Mutual forwarding and mutual promotion would help to address a broader community and benefit from each other's strengths.

5 EMPIRICAL RESULTS - FINLAND

5.1 General remarks and background

The Finnish case study is more limited compared to the Austrian case. This is mainly due to smaller research effort as well as to the fact that the CS market in Finland is seemingly less mature compared to Austria. There are only few cases of true climate services use beyond basic climate information provision by meteorological institutions. Due to this nature of the market, this analysis has not been divided as above in user and provider side reviews. Instead, the results are presented for both sides together. Interview and survey results are discussed together within the same section.

Tourism in Finland is on the rise, and especially tourism in Lapland and Kuusamo is enjoying steady expansion (Visit Finland 2018). The biggest two resorts account for one third of the market, the biggest four for about half of the market volume (Ski.fi 2017). There are ski resorts across the country, but in terms of skiing days, Northern Finland accounts for over 60 % (Ski.fi 2017). The nature of tourism is also different. In Northern Finland the role of foreign tourists and those staying longer periods of time is far more important, in the South day trips are more typical. The amount of annual skiing days (i.e. days when conditions enable skiing either through natural or artificial snow) have remained around the same for the last ten years, but it should be noted that the capacity to make or store snow has improved during the time.

The projected changes in Finland and specifically in Northern Finland are significant. Depending on how global warming develops, the decrease in snow cover days in Southern Finland is expected to be within the range of around one to three months by mid-century (Climate Guide 2017). For Lapland this would mean that around 2050 on average the winter season could start a month later and end a month earlier. In Southern Finland by contrast there would be a high risk of winters without practically any lasting natural snow by mid-century. The annual average temperature rise is expected to be in the approximate range of 2 °C to 3.5 °C in Finland by mid-century, with higher rise occurring in winter months and in Northern parts of the country (Ruosteenoja *et al*. 2016)

5.2 Risk perception

The risk perception regarding climate impacts to the sector are varied. Most interviewees and respondents considered climate change as a significant factor and noted that their business is at least somewhat vulnerable to climate. Most important issue is snow period and the related length of the winter season, which is the economic basis of the business.

Regarding long term climate change the perceptions varied from very concerned to borderline climate change skepticism. Some stakeholders brought up that they had already perceived changes, while others emphasized that climatic variability has been an issue already before, and the businesses are used to the season length varying within the limits of several months. Vulnerability to climate risks was also considered to be decreased by the fact that most of the trips are booked well before the season, so unfavorable conditions affect mainly indirectly.

Changes in snow trends are the most significant risk, but not the only one. Extreme coldness, strong winds and periods where temperature “saws” around zero degrees Celsius were also considered problematic and even dangerous to outdoor activities. The tourism activities based on sea ice in Bay of Bothnia are

naturally dependent on ice conditions, and cloud cover is problematic for northern lights spotting – an important form of tourism outside ski resorts. For summer season, long lasting wet periods are unfavorable. Naturally climate trends that significantly affect any of these conditions are a significant change for the stakeholders as well. The exoticism of Finnish nature itself has value for tourism.

> "Seasonal climate variability has some effect, but often travel plans are made so long before the trip that the tourists rely on the expected climate. Especially tourists flying from afar (China, Japan, Singapore, U.S., Australia) make their bookings early on. Then on site, weather information has great impact on the specific program choices. […] Due to earliness of bookings, dynamic climate information is not used."
>
> *(Municipality tourism director)*

The combination of increased tourism and extreme weather can also result in new risks. The municipal infrastructure and disaster risk management are designed mainly with the local populace in mind, while in practice the amount of people in the area can be multiple times higher at a given time during the season. Ski resorts depending on single roads could be cut off by a heavy snow storm and the nearby communities are not equipped to take care of the peak tourist masses during disasters caused by severe or extreme weather.

Some interviewees also noted that the global climate change presents some opportunities to the Finnish winter tourism, both in the interviews and the survey. The perception is that snow conditions in Northern Finland are less vulnerable to changing climate compared to the Alps in Central Europe. This is not only an issue in the future, but according to some, is already happening. Cleanliness and pure nature were mentioned also as competitive factors of Finland. While these are not exactly climate issues, these were often brought up in the same context.

> "It has also already impact in the sense that, as the conditions in the Alps have gone worse, more people from central Europe come here. Probably impacted the flight connections too. We are the biggest Swiss destination in Lapland. They tell that snow conditions in their previous sites in the Alps have worsened."
>
> *(Municipality tourism director)*

Despite the perceived risks, climate seems to have limited influence on decision making in the tourism sector. The growth of tourism in Finland and especially in Lapland is the main driver of development and investments. Many of the investments work as climate adaptation measures: Improved snow making equipment or storage, mountain biking trails or indoor facilities for year around snow castle all reduce climate vulnerability. Yet they are mainly rationalized by more direct business benefits of lengthening season and increasing vacancy rates. The public infrastructure investments are aimed to enable and foster the ongoing growth trend. Climate risks and opportunities are not ignored, but they are not the determining factor, as the following quote illustrates:

> "There are a lot of "soft" facts in play in decision like this, even gut feeling matters a lot. In a context like this, assessing in detail how the climate there is developing, how it affects tourism there and so on, well… not that relevant."
>
> *(State infrastructure company)*

Table 16 summarizes the perceived risks. The risks are categorized based on the type of tourism activity – some risks were identified to especially affect the ski resorts and ski tourism, others tourism in general in the area.

TABLE 16: RISK PERCEPTION OF THE FINNSIH STAKEHOLDERS

	Perceived risks
Ski resorts	– Delayed start of the season – Early end of season – Dangerous wind conditions – Extreme coldness – Increased ski track maintenance costs
Municipal and regional authorities	– Conflicting image ("winter wonderland") and reality – Loss of sea-ice – Cloudiness preventing northern lights sightings – Increased nature track maintenance costs – Changes in natural product availability – Delayed start of the season – Early end of season – Disasters induced by extreme weather
State authorities	– (all of the above)

5.3 Current use of climate services and current CS supply

Currently the use of climate services within the sector is very limited and informal. Weather services are used routinely and local organizations of different sizes are quite critical consumers of weather information – there are clear views on which service provider seems to give the most accurate predictions for their region. Climate services in contrast are used sporadically in combination with local, traditional knowledge on local conditions.

> "Of course, we have business and market analysts looking at all kinds of data, but climate information is not used in systematic assessments or planning. […] I try to concentrate on the very core issues – everything else is just noise around. Otherwise you just drown in the information."
>
> *(State infrastructure company)*

The source of climate information in use at the moment is media, joint projects and public communications of climate research institutes. Those organizations big enough to employ analysts or undertake systematic market analysis may seek for more detailed data on climate, but mainly to be used as background information. Many of the stakeholders were aware of the climate service spectrum of CS suppliers on a general level, although understanding of what falls under weather and what under climate varies. NMSs were typically acknowledged as the main CS suppliers.

Use of climate services in decision making is however not completely unheard of. In joint development project and research and innovation activities climate services have been used to understand the future conditions for business development and to support snow storage management.

5.4 Perceived barriers to the use of CS

There are several perceived barriers to the use of CS among Finnish stakeholders. These are listed below in Table 17. The main barrier is related to perceived risks. In general the time horizon of climate risks is considered too long compared to the business decision cycles and this results in low prioritization of climate issues. This low priority is reflected in organizational capabilities too – few stakeholder organizations have expertise or processes to use climate services extensively. This is not to say that the organizations would not understand the role of climate in their operations. In fact there is high level of expertise about managing businesses in variable climate and using weather services professionally.

> "Warming is happening too slowly to affect that much the decision-making of many stakeholders."
>
> *(Municipal tourism representative)*

Organizational barriers exist as well. The Finnish tourism sector consists mainly of small and medium sized enterprises, and even the few larger ones have limited capacities beyond their core competence. The available time, effort and expertise are prioritized on other issues. In addition, climate issues are still often contextualized in terms of corporate social and environmental responsibility, although awareness of physical climate risks is increasing.

Uncertainty in how responsibility is divided among different organizations may hinder CS use as well. Municipal, regional and state authorities view themselves largely in position to mediate information to the businesses, whereas businesses consider climate change adaptation beyond operational planning to be the domain of public policymaking, or at least public sector to support in funding it. In such situation no single actor sees itself as the clear first level user of climate services.

Limited adaptation options also form a barrier. While few explicitly stated this, it seems that for a business completely dependent on the climate conditions – take snow safaris for example – the business ceases to exist if the conditions for it are lacking. On a system level there are adaptation options of course, such as focusing on year around activities, but for a micro enterprise organizing climate dependent activities adaptation would in practice mean complete transformation of business.

Unsurprisingly also the quality and form of climate information is still a barrier. The inherent uncertainty of mid and long-term climate scenarios limits their usefulness and the quality of seasonal prediction is not considered high enough when weighed on the opportunity costs and risks of measures guided by such predictions. Spatial accuracy is a determinant for usefulness, and even regional data is often considered

too inaccurate as specific local conditions vary. As for the form of information, brief and visual data is appreciated – again due to the organizational limitations for use. Scientific representations or long reports are not preferred.

TABLE 17: PERCEIVED BARRIES BY THE INTERVIEWED STAKEHOLDERS

	Type of barrier	Perceived barriers
Users	*Awareness*	– Missing conviction on the benefits of using CS – Contextualization of climate issues within CSR activities
	Priorities	– Short planning horizon of tourism businesses – Weather services and seasonal forecasts more relevant – Importance of climate in decision processes overestimated (by climate community)
	Applicability	– Time horizon of climate risks and operations – Lack of adaptation options – Complex forms of available information
	Lack of trust	– Uncertainties of projections
	Organizational	– Lack of expertise or resources – Division of responsibility between actors – Lack of legal responsibility

5.5 User needs

The nature of both the risk perceptions and the CS use barriers needs to be acknowledged when considering user needs. Due to low prioritization and organizational limitations only few of the stakeholders articulated clear user needs for CS. Some general remarks regarding views on CS supply can however be summarized.

A frequently expressed view was that the communication of general climate information should be improved. There is demand on short, clear briefs about the climate and its predicted impacts. Such service could increase climate awareness among the sector, as such information now comes sporadically from various sources. The good reception of the project leaflet also indicates that such form of information is welcome. This demand however has limited market potential as willingness to actually pay for such information is low.

> "Maps are in general easier to digest than texts. Easy to use applications are the thing today and probably also in some form in the future."
>
> *(Municipality representative)*

In general, there are hopes to see more accurate climate information. Regional data is a necessity, concerning current weather and climate services, however, Finland is divided into regions that do not reflect the needs and wishes of the tourism sector. For climate scenarios Finland should at least be divided in Southern, Central and Northern parts. In any more detailed information much more spatial accuracy is

required since the local conditions in the resort areas can be very specific. Accurate seasonal forecasts could be used in operational decision-making. Otherwise time frames of 5 and 20 years are of interest.

5.6 Summary

Based on the interviews and surveys it seems that there is no major market demand for climate services in the Finnish tourism sector. Low prioritization and organizational limitations are high barriers when compared to the level of accuracy climate services can supply at the moment. There is interest towards the topic and increased learning and co-operation, but willingness to pay seems low. Whether increased awareness would substantially change this situation remains unclear. Already the work done within EU-MACS together with the sector has resulted in increasing interest and some media coverage, so the views summarized and analyzed here can become outdated fast.

Whatever the market potential is, the recommended next step is to improve the communication of climate information in general in co-operation with state, regional and local organizations. This low cost action would mainly require only improved design and communication of existing data and information. Resulting improvements in understanding climate and its impacts could result in demand of more detailed, tailored service production, although this remains questionable. Municipal organizations are in key position in the local information networks but have limited capabilities to process or purchase services. The necessary funding and organizational capacities are better on state and regional organizations, which are perhaps best suited to be the key customers in any more effortful service process. Biggest tourism actors, such as the main ski resorts might however demand specific, tailored information products as well.

In regards to climate change adaptation in general the growth of the tourism sector has the biggest short-term impacts. The investments in infrastructure and facilities are likely to improve the adaptive capacity on short and medium term. However, the sustainability in long term is more uncertain. Mitigation pressures for aviation emissions can hinder the growth and the shortening snow season starts eating out the profitability at some point. This is likely to happen much earlier in the Southern parts of the country, and the indirect impacts of this to the whole sector are difficult to assess.

6 CONCLUSIONS AND RECOMMENDATIONS

In this study we identified the constraints and enablers shaping climate services take-up in the Austrian and Finnish tourism sector. Overall, it seems that there is no major market demand for climate services in the tourism sector. The perceived barriers to the use of CS and identified user needs are quite similar in both countries. The following conclusions and recommendations can be drawn[7]:

Awareness-raising is still one of the main drivers for CS take-up. If potential users are not aware of their climate risks, they will not see a need for CS. The risk awareness depends on the current level of suffering from climate variability and extreme events, but also on personal characteristics like age and level of education: The younger generation of tourism service providers tends to be more risk aware.

Even if there is climate risk awareness, **lack of long-term risk management often still hinders the use of CS**. Many interviewed stakeholders indicated that they have rather short business decision cycles (five years ahead at maximum). Thus, if at all, they showed higher interest in weather services and seasonal products. However, dealing with weather variability and using weather services may also increase to some extent the interest in climate services 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).

Climate services and their benefits of use need to be better demonstrated and communicated. Tourism businesses are often not aware of existing CS and CS providers and where to find reliable information. The communication channels of interest groups (e.g. provincial tourism associations, ropeways association) could be used to present the latest findings of tourism related climate research and to demonstrate the added value of CS. This could be also shaped as communities of users, as tourist professionals may easier accept recommendations from their peers than from experts outside the tourism sector.

In addition, a platform to present providers and their CS would improve visibility. For example, the climate research network in Austria (CCCA) has an initiative to map climate researchers and their expertise ('Kompetenzlandkarte'). This 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 service. The CCCA is a contact point for researchers, politicians, the media, and the public for all questions concerning climate research in Austria, but the institution seems not to be widely known among private end-users. Hence, the visibility of the CCCA in particular among private companies and organizations as a contact point needs to be enhanced.

Addressing climate risks is a complex issue that requires additional resources besides tourism service providers' daily business. In this context resources refer to a mix of hired expertise, acquired skills and knowledge, extra labour effort, extra management information, and equipment, fitting for the organisation. Such resources are needed to use or interpret climate data and to provide business/region-specific data. **Hence, if the financial pressure and suffering is not high yet, business managers take priorities other than looking into climate issues.**

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

[7] In order to provide a more comprehensive picture, important conclusions and recommendations from MARCO Deliverable D5.10 (Case Study 9 Report – Tourism, Köberl *et al.* 2018) are included as well.

impacts and adaptation options. Financial capacity is another aspect in this regard. Whereas for large and high-selling companies resource limitations tendentially take a back-seat to other criteria, it ranks higher for small companies or regional tourism associations. Overall, better communication and demonstration of the benefits of CS use could increase the willingness to pay for tailored services as well.

Furthermore, CS will get more affordable (a) as part of a package with other, anyway 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 interest in CS – be it on a local or regional scale (like a tourism region) or be it from the same kind of business perspective (like a group of hoteliers or an association of ski lift operators). So, there is a chance that CS can be supported by umbrella organisations.

It seems improbable that systematic support from the public sector will arise, e.g. in terms of subsidies to be spent on CS. Subsidies aside, **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 elsewhere proven to be promising. So, it would help if actors (a) 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 (b) if it became common practice to require a sort of climate risk assessment for subsidies and other permissions to engage in tourism. Matching demand and supply of CS would mean to **offer sets of arguments** for typical businesses and policy-makers in tourism on **how money could be saved** through using CS.

Countries in which **the use of meteorological data for commercial purposes is associated with high costs** (e.g. Austria), the provision and take-up 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. Hence, **an open public data policy would facilitate CS provision; also new cooperation models on the supply side of CS could help.**

The market would benefit from a more diversified set of providers and more intermediaries bridging the gap between research and applicability. Currently, CS are mainly provided by research institutions alongside to their research and teaching activities. Hence, too little emphasis is put on product development and design, sales and marketing as well as consulting activities. There is a need for intermediaries to establish a better link between science and potential end-users. This is in particular relevant as the use and interpretation of climate data tends to be time consuming and to require specific skills. This may also include enticing tourism consultants to act as purveyors of climate information, i.e. incorporate climate information into their services.

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. **Funding schemes** explicitly addressing adaptation and mitigation and the development of prototypes in the tourism sector could help to overcome financial barriers. There is an articulated need for spatially detailed information and guidance on how to interpret the results, what they mean for a particular tourism region, how to prepare for and adapt to a changing climate. Hence, consulting is considered highly relevant.

Weather and climate data on their own do not suffice for stakeholders to make decisions, as weather and climate are just one of many factors that influence tourism demand. Stakeholders emphasize the need for market research about demand in relation to climate (change), considering also general trends in tourism demand and leisure activities as well as demographic changes. They also suggest finding ways

to integrate more CS into common tourism consultancy services in order to see climate issues as part of the bigger picture.

From stakeholders that are newly looking into potentials of CS for their purposes we learn that matching could mean first checking on what it is, what could be in it for us; it is about trying to find objectives for using CS or not. This could be called '**Explorative CS'**. More '**Dedicated CS'** would pick up from far more specific or urgent interests, while users would already be having better defined objectives for using CS. These patterns can be seen in context of a **key role for intermediaries**, knowledge brokers, etc. that can connect demand and use, mere curiosity and keen interest, small and big actors, single actors and communities. Novel business formats should be seen as part of this: Platform business models could allow such matching on all kinds of channels that would work for users and providers.

The question to be answered within the rest of the EU-MACS project is: **Who will take the innovation leadership** at the end of the day – on both sides, demand and supply?

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ANNEXES

ANNEX A – Interview guidelines

Interview guideline for CS providers

The EU-MACS project

EU-MACS is a project funded by the European Union as part of the Horizon 2020 Research Programme, and runs from 1.11.2016 to 31.10.2018. The study aims to clarify how the market for climate services could be improved in its functioning and thereby enabled in its growth. The study reviews the obstacles, biases, and missing elements hampering the dissemination, uptake and use of climate services, as well as the opportunities for upstream and downstream innovation options in climate services.

The project focuses on the market for climate services in three sectors, with tourism representing one of them. In an interactive process – consisting of interviews and two workshops – key market barriers and enablers will be identified in close collaboration with stakeholders from the tourism industry. The first workshop (planned in September 2017) aims at elaboration the requirements on climate services for different types of potential end-users in the tourism sector. Based on the insights gained, new concepts of climate services for the tourism sector are developed and further discussed in a second workshop (planned in January 2018). Participants of the stakeholder interviews and workshops may articulate their needs and proactively shape the design and supply of customized climate services in the tourism sector, gain advance in knowledge and benefit from early adoption of climate services and timely consideration of climate risks in their long-term risk management and business/tourism planning.

Climate services – definition:

EU-MACS employs the definition of climate services as formulated in the EC's Climate Services Roadmap: "…., we attribute to the term a broad meaning, which covers 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. As such, these services include data, information and knowledge that support adaptation, mitigation and disaster risk management (DRM)."

Project website: http://www.eu-macs.eu

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WHO is offering climate services?

1. What is the name of the organization you are working for?

2. What type of organization is it?
   (University / University of applied sciences / Research institute / Private enterprise / Non-profit organization / Research network / University network / Public authority, Institution of a federal state / Others – please specify)

3. How many employees does your organization have?
   (1 to 10 / 11 to 50 / 51 to 200 / 201 to 500 / More than 500)

WHAT kind of climate services do you offer?

4. Which climate services do you offer for the tourism sector?

   a. What is the **type** of your services?
      (basic climate data / processed physical information (e.g. hydrological/snow models) / early-warning systems / economic impacts (e.g. sales, visitor numbers, overnight stays) – vulnerability analysis / cost-benefit analysis / macroeconomic impacts / weather insurances / consumer behavior / mitigation strategies / adaptation strategies / consultancy / training / other – please specify)

   b. Which **time horizon** is relevant for your service?
      (Past / Present / daily forecasts / Seasonal projections / Future - until 2040, 2070, 2100)

   c. What does the **delivery relation** look like?
      (climate service is delivered: (1) one time, (2) recurrently (monthly, annually), (3) at irregular intervals)

   d. What is the **spatial scope** and **spatial resolution** of your services?
      (Local / Regional / National / Transnational / Continental / Global)
      (grid size, NUTS regions)

5. Do you offer services **tailored** to the users?

6. How do you **disseminate** the service to the user? (You can indicate more than one option, please order them by significance of use.)
   (Reports / Data / Graphics, maps / Online platform (general – or client access) / (Online) Tool / Workshop / Face-to-face advice / Presentation of results / Media / Others – please specify)

7. Do you need data from third-party suppliers to offer your services? If yes, which kind of data and who is the provider?

8. Do you **pay** for the (climate) data you use for your services? If yes, how much (per year)?

Users

9. Who are the **users** of your service? (Please order according to their significance.)
   (researchers / consultancies / decision makers/ politicians / practitioners / general public)
   (tourism specific: tourism associations, travel agencies, accommodation facilities, recreation facilities, etc.)

10. Why do users choose exactly your service?
    (e.g. most fitting contents / information quality / way of delivery / prior experience / prior contacts / regulated monopoly (so no choice))
    Did users consider also other CS service providers before choosing your organization?
    Did users have other CS providers before choosing you or did they somehow gather information for free?
    Do users also acquire CS from other providers alongside your services?

11. What do the users use your service for?

12. Are users allowed to re-use the information acquired from you as part of own service delivery or share it with (close) allies? If so, are there conditions and price consequences attached to such re-use?

Relationship between provider and user and product development

13. What factors motivated you to develop climate services? (You may indicate different sub-sets of reasons for different climate service products)
    (own initiative / on demand of specific user(s) / as an externally financed research project / other)

14. Does your service totally meet the users' needs (e.g. concerning spatial or temporal resolution)?

15. How do you initially get in contact with users?
    (We contact potential users of our services. / We are contacted by potential users of our services. / Other)

16. How many follow-up orders of your services do you have? Have the requirements been expanding?

17. Do you **promote** your service? If yes, how? Which type of media do you use?

Financing (commercial/ free of charge)

18. How do you **finance** the provision and the development of your service?
    (With public funds / With private funds / Hybrid forms - please specify / Research funding / Through payments for the services)

19. Are there any **restrictions** caused by the financing?
    (e.g. is your climate service project-bound? Or does the funding source preclude certain business models w.r.t. service delivery?)

20. Do users **pay** for the service? If yes, how many paying clients do you have (yearly average)?
    And what is payment system? *(e.g. per delivery, one time access fee, annual access or membership fee, marginal fee for non-standard work only, 3rd party (co-)funding (user and payer are not the same).*

Uncertainties and quality assurance (QA)

21. How do you communicate **uncertainties** and limitations related to your service?
    a. Do you focus on the provided climate information 'only' or do you judge uncertainty also with reference to the use context?

22. How do you **assure quality** of your services?

    a. Do you apply any formal quality QA processes?

    b. Are your services evaluated? If yes, by whom, and how?

    c. Do you use QA results for presenting / positioning your CS products for customers / customer groups or informing potential users about implications of particular choices?

23. How do you **assess the quality** of data/information you use as input for your services?

Climate services market in tourism

24. What kind of partners does your organization collaborate with regarding climate services in the tourism sector?

25. Are there **any other institutions** which offer similar services to yours? Which other climate services and service providers for the tourism sector do you know?

Barriers

26. In your opinion, what are the **barriers of using** CS? Why are CS not used more intensively by organizations in general and the tourism sector in particular?
    (risk awareness, uncertainties, suitability of available information/services (e.g. temporal or spatial scale), lack of knowledge regarding the interpretation of data/results, lack of knowledge regarding information sources/ providers, lack of access to climate data/information, budgetary constraints, etc.)

27. What are the **barriers of providing** customized CS? Has your organization, to your knowledge, encountered any obstacles in producing climate services?
    (e.g. access to data, any legal obstacles, lack of demand)

28. In your opinion, what would be necessary to **enhance** the market growth of climate services in the tourism sector?

29. What kind of changes in the way and structure of climate service provision do you foresee for the next ~5 years?

Interview guideline for tourism end-users

The EU-MACS project

EU-MACS is a project funded by the European Union as part of the Horizon 2020 Research Programme, and runs from 1.11.2016 to 31.10.2018. The study aims to clarify how the market for climate services could be improved in its functioning and thereby enabled in its growth. The study reviews the obstacles, biases, and missing elements hampering the dissemination, uptake and use of climate services, as well as the opportunities for upstream and downstream innovation options in climate services.

The project focuses on the market for climate services in three sectors, with tourism representing one of them. In an interactive process – consisting of interviews and two workshops – key market barriers and enablers will be identified in close collaboration with stakeholders from the tourism industry. The first workshop (planned in September 2017) aims at elaboration the requirements on climate services for different types of potential end-users in the tourism sector. Based on the insights gained, new concepts of climate services for the tourism sector are developed and further discussed in a second workshop (planned in January 2018). Participants of the stakeholder interviews and workshops may articulate their needs and proactively shape the design and supply of customized climate services in the tourism sector, gain advance in knowledge and benefit from early adoption of climate services and timely consideration of climate risks in their long-term risk management and business/tourism planning.

Climate services – definition:

EU-MACS employs the definition of climate services as formulated in the European Commission's Climate Services Roadmap: "…., we attribute to the term a broad meaning, which covers 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. As such, these services include data, information and knowledge that support adaptation, mitigation and disaster risk management."

Project website: http://www.eu-macs.eu

Contacts:

Andrea Damm, Joanneum Research (andrea.damm@joanneum.at), tourism work package leader

Adriaan Perrels, Finnish Meteorological Institute (eumacs.coord@posti.fmi.fi), project coordinator

Risk perception

1. Could you please describe how current **climate variability** (i.e. the way climate fluctuates seasonally/yearly above or below a long-term average value) and extreme weather events affect your business and the tourism sector in your region in general?
    a. What kind of climate conditions? (e.g. unusually rainy, hot or cold summers/winters, extreme events)
    b. How is your business / the tourism sector affected?
    c. How do you deal with these impacts?
    d. **How vulnerable** do you perceive your business / the tourism sector with respect to climate variability and extreme weather events (on a scale from 1 – not vulnerable to 5 – very vulnerable)?
2. How do you think is **climate change** going to affect your business / the tourism sector?
    a. Are you already experiencing these impacts?
    b. What are your strategies to deal with these impacts?
    c. **How vulnerable** do you perceive your business / the tourism sector with respect to climate change (on a scale from 1 – not vulnerable to 5 – very vulnerable)?
3. Do you **feel well informed** about climate change and climate change impacts on tourism?

Current use of climate information / climate services

4. **Which climate information** or services do you use (a) in your **daily operational business** and (b) in your **strategic business planning**?
   (basic climate data / processed physical information (e.g. hydrological/snow models) / early-warning systems / economic impacts (e.g. regarding sales, visitor numbers, overnight stays) – vulnerability analysis / cost-benefit analysis / macroeconomic impacts / weather insurances / consumer behavior studies / mitigation strategies / adaptation strategies / consultancy/ training / other – please specify)

   If climate information/services are used:

   - **What** do you use the climate information/ service **for**? Which kind of decision is taken based on this information/service? Do you use CS for monitoring purposes?
   - How long have you already been using CS?
   - Do you use **tailored climate information**?
     If yes. Please describe the kind of tailoring.

     (Tailoring of otherwise standard (quantitative) product/ Tailoring in terms of dedicated commissioned CS / Does tailoring entail consultancy and/or training?)
   - Do you combine – in a formal sense – CS information (data) with other information (data)?
     .1. If so, does the amount and features of the other information (data) affect the CS choices and formats?
     .2. Do you experience limitations in the use of CS owing to difficulties in merging the data?
   - What is the **spatial scope** and **spatial resolution** of the service?
     (Local / Regional / National / Transnational / Continental / Global)

     (grid size, NUTS regions)
   - What is the **temporal scale** of the service?
     (Past / Present / daily forecasts / Seasonal projections / Future - until 2040, 2070, 2100)

- **In which format** do you **receive** the climate information/ service?
  (Reports / Data / Graphics, maps / Online platform (general – or client access) / (Online) Tool / Workshop / Face-to-face advice / Presentation of results / Media / Others – please specify)
- How often do you receive the climate information/service?
  (one time / recurrently (monthly, annually) /at irregular intervals)
- Who is the **provider** of this information?
- How did it come to the use of the climate service / information?
  (Own initiative / Contacted by climate service providers / Involved in research projects / Other – please specify)
- Is the information easily **understandable**?
- What is your experience regarding the effectiveness of using climate information or services?
  (cost savings, optimization of planning etc.)
- Do you **pay** for the climate information/ services?
  If no. - Would you pay for (tailored) climate services?
- Does the use of the CS in your organization cause other notable costs?
  (Owing to CS acquisition cost / Owing to the necessity to invest in equipment or software to use the CS (one time cost) / Owing to the necessity to recruit or hire expertise labor (continuous or recurrent cost))

If none:

- Why not? *(risk awareness, uncertainties, suitability of available information/services (e.g. temporal or spatial scale), lack of knowledge regarding the interpretation of data/results, lack of knowledge regarding information sources/ providers, lack of access to climate data/information, budgetary constraints, etc.)*
- Are you planning to?

Identifying users' needs/perspective

Already users:

5. Apart from the climate information / services you already use, which of your activities or services could be improved with greater knowledge/understanding of climate variability and change – briefly explain why and how? (What kind of weather/climate information or service would be important for your activity?)

Non- users:

6. Which of your activities or services could be improved with greater knowledge/understanding of climate variability and change – briefly explain why and how? (What kind of weather/climate information or service would be important for your activity?)

Quality assurance

7. How do you / would **you assess the quality** of climate information and services?
   (e.g. regarding the suitability of available information and services / transparency (meta-information) / provision of uncertainty information / matching spatial and temporal resilience / user-friendliness / selection of providers (reputation, publication record etc.)

Already users:

8. Has quality assurance been an issue in the choice of CS provider(s)?

Stakeholder network analysis (SNA)

9. Could you please describe **your role in tourism planning and development** in your region?
    a. Could you please list the actors with whom you interact for these reasons?
    b. Could you please describe the kind of interaction you have?
    (e.g. information providers/ receivers, strategic planning)
    c. Could you please assess the importance of these interactions (on a scale from 1 – not very important to 5 – very important)?
10. Do you **collaborate** for reasons of **climate change adaptation**? (Do you share climate information with allied organizations?)
    a. Could you please list the actors with whom you interact for these reasons?
    b. Could you please describe the kind of interaction you have?
    (e.g. sharing of climate information/services (providing/ receiving), strategic planning)
    c. Could you please assess the importance of these interactions (on a scale from 1 – not very important to 5 – very important)?
11. Do you **wish for more cooperation** in respect of climate change adaptation? Please explain with whom, why and how?
12. According to your experience/opinion, could you describe some **limits/drawbacks** of the current interaction network **hampering the process of climate change adaptation**?
    (e.g. lack of information sharing)

General information (tourism stakeholder)

13. What **kind of tourism service**(s) do you provide?
    (accommodation; outdoor tourist/leisure infrastructure (e.g. skilift), outdoor tourist/leisure services, indoor tourist/leisure services, tourism relevant retail, tourist information, (regional) tourist promotion & coordination, transport, restaurants, etc.)
14. What **type of organization** is it?
    (Public / private – commercial / non profit)
15. How many **employees** does your business have?
    (1 to 10 / 11 to 50 / 51 to 200 / 201 to 500 / More than 500)
16. What is the average **number of customers/visitors/overnight stays** per year in your business?
17. Do you operate at more than **one site**? If yes, where?
18. What is the usual **planning period** in your business and what is the usual time horizon of investments?

ANNEX B – Online survey

The online survey on climate information and decision-making to Finnish experts

The survey had two parts. In Part 1 the following five predictions were given to the respondents one by one, and after each the respondents were asked the following questions:

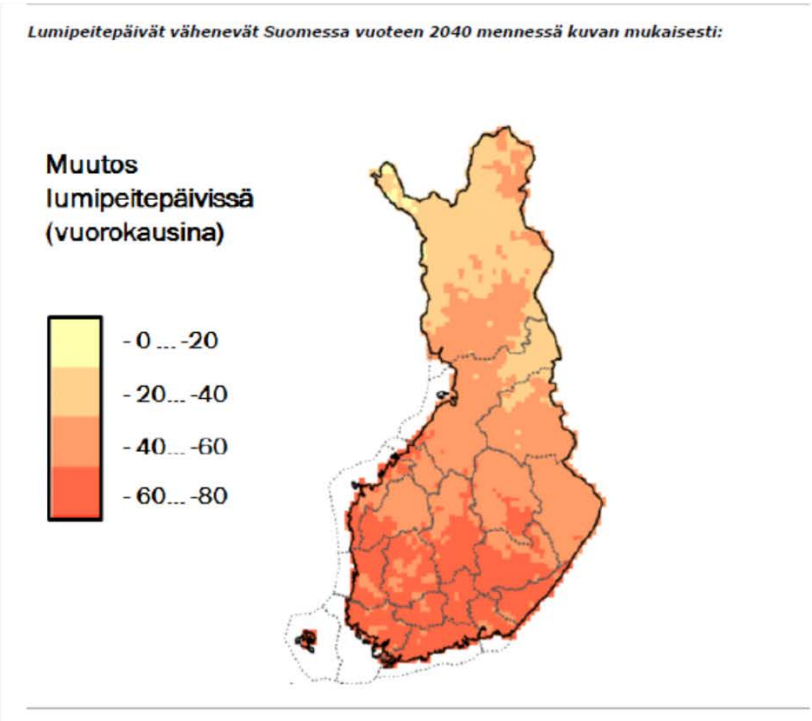
1. How significant is this information?
2. What actions does this information cause and on what time frame?
3. What actions do you expect from others? From whom?
4. What additional information would you want regarding the prediction?
5. Other ideas about the prediction and the form it is represented in?

Prediction 1:
Next spring (March-May) has 70 % likelihood to be warmer than average, meaning also a month shorter snow season.

Prediction 2:

(engl. Snow cover days decrease in Finland by the year 2040 according to the figure:

(Change in snow cover days in days))



Prediction 3:

The occurence of strong winds (over 14 m/s) and storms (over 21 m/s) in Finland may increase 10 % by the year 2030.

Prediction 4:

The climate in Finland warms in the future according to these tables (in relation to current climate):

January / July

Low estimate
Medium estimate
High estimate

Tammikuu

	2025	2035	2045
Matala arvio	-0,2 °C	0,7 °C	1,4 °C
Keskiarvio	1,9 °C	2,9 °C	3,8 °C
Korkea arvio	4,0 °C	5,0 °C	6,3 °C

Heinäkuu

	2025	2035	2045
Matala arvio	0,3 °C	0,6 °C	0,8 °C
Keskiarvio	1,2 °C	1,7 °C	2,2 °C
Korkea arvio	2,1 °C	2,9 °C	3,6 °C

Prediction 5:

The amount of snow in the Central European Alps decreases by half by the year 2050.

In Part 2 the respondents were presented with the table below, and asked the following questions:

1. Which of these do you consider most useful?
2. Why?
3. Which of you would you be willing to pay for?
4. Additional thoughts on pricing?

A) Commonly available maps and apps describing climate information relevant for tourism sector	B) Commonly available expert analyses and reports on climate impacts for tourism sector
C) Targeted expert services on climate change and climate impacts (e.g. regional "service desk"	D) Tailored projects on climate change and climate adaptation (for example consulting projects supporting an investment plan or strategy work)

ANNEX C – Leaflet

The project leaflet distributed to Finnish stakeholders

Front side:

CLIMATE SERVICES SUPPORTING TOURISM DEVELOPMENT

Climate change affects tourism in the north

Climate in Finland is warming faster thatnthe global average, and the temperatures are expected to increase by several degrees towards the end of the century. In the Southern Finland wintery conditions become less frequent and in the Northern Finland the length of the snow cover period may shorten by a month by 2050. Wind conditions may become more challenging as well. Still, the characteristic variability of the Finnish climate remains.

More information: ***www.climateguide.fi***

The tourism sector looks for accessible and accurate climate services

Climate services aim to produce user-oriented climate information for different industries. In Finland the tourism sector expects adequate temporal and spatial accuracy to support decision making. Increasing awareness of climate change among the industry and its clients is considered important but the specifics in local impacts should be accurate. Skiing continues in the north also in the future and artificial snow can alleviate if conditions get worse. Seasonal forecasts can support ski resort business planning if they become more accurate. Shorter six week forecasts for Finland are currently developed within the CLIPS project, where pilot phase is open for participants.

More information on the six week forecasts: ***clips.fmi.fi***

EU·MACS

Finnish Meteorological Institute is researching climate services for tourism sector within the EU funded EU-MACS project.

More information: ***www.eu-macs.eu****, twitter: @EUMACS_H2020*

Researcher Atte Harjanne (atte.harjanne@fmi.fi)

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FINNISH METEOROLOGICAL INSTITUTE

Back side:

Adapting to changing climate

Change is always an opportunity as well. Winter tourism businesses can adapt to climate change by investing in year around services and preparing for deteriorating snow conditions with artificial and stored snow. Ability to react flexibly to the changes in the length of winter season is important as well. Scenarios of climate change and its impacts can be used to guide long term investments in new infrastructure.

In the Alps climate services are already in use

In Austria tourism sector has succesfully used climate services in adapting to climate change. The state of Lower Austria conducted an assessment on the future snow conditions within the ski resorts of the region as part of the development of a new tourism strategy. Based on the results the state has focused infrastructure development to higher laying areas and improved conditions for year round tourism.

In the state of Styria a municipality owning a local ski resort ordered an assessment on how to prepare for changing climate in investment planning. A study combining climate science and economic assessment guided the ski resort to optimize the use of snow making equipment.

Finnish Meteorological Institute participates also in the MARCO project, the sister project of EU-MACS. The project takes a broader look on current use and demand of climate services. Work in MARCO has already brought up encouraging examples of services use that could be utilized also in Finland.

More information: ***marco-h2020.eu***

www.eu-macs.eu

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ANNEX D – Value Proposition Canvas

TABLE A. 1: VALUE PROPOSITION CANVAS – TOURISM ASSOCIATIONS

Customer Jobs	**Products & Services**
• To attract tourists (high occupancy rate) • Awareness-raising / Training/ Coaching • Service value chain	• Weather-based packing list for tourists • Dynamic pricing (weather-dependent) • Guest monitoring (what are guests doing during bad weather conditions?)
Gains	**Gain Creators**
• Peak demand management • Regional development – Further development of products and creation of new products e.g. snow shoe competitions • Strategy process • Co-working…Digitalization	• Weather-based activity recommendations tool – Requires improved weather forecasts – Who should pay for the services? Which services are listed in the recommendations? Only those who pay for the service? -> conflict, because of compulsory membership in tourism association. • Digitalization – funding options (e.g. LEADER project)
Pain	**Pain relievers**
• Lack of time, lack of financial resources • Responsibility for both o stakeholders / tourism service providers o tourists (inner conflict) • Low product/service quality of some members (for many tourism service providers – secondary occupation) • Responsibility for quality assurance but without regulatory power • High seasonal fluctuation in occupancy; low occupation rates in shoulder seasons	• Regular exchange between tourism associations (also of different provinces) Bundling of resources • Customer feedback (quality assurance) • CS – tourism associations share of turnover (e.g. 10 %), but tourism association is a non-profit organization, i.e. brokerage • Holistic planning process (including also climate issues), prioritization of tasks, budget planning,

TABLE A. 2: VALUE PROPOSITION CANVAS – SKI RESORTS

<table>
<tr><td>Customer Jobs

• Provision of optimal snow cover:
– (Natural snow)
– Snowmaking
– Snow (height) management (snow production and distribution)
– Snow production planning, based on short-term weather forecasts
– Snow fences for natural snow depot (i.e. exploiting wind transport of snow)
– Snow farming
– Grooming of ski slopes
• Avalanche protection
• Wind protection for ropeways
• Informing guests about snow conditions and open ski lifts and slopes
• Pasture management (in summer)
• Constructional adjustments of ski slopes (in summer)</td><td>Products & Services
• Customized weather forecasts, using observation data of ski resorts</td></tr>
<tr><td>Gains

• Winter feeling in urban regions
• Optimization of slope design
• Higher guest satisfaction at lower guest frequency
• Energy balance/ CO2 footprint (?)</td><td>Gain Creators
• Monitoring of energy use
• Ecological footprint</td></tr>
<tr><td>Pain

• Poor slope conditions/ snow conditions
• Distribution of snow
• Foehn events, extreme precipitation
• Water availability
• Regulations (timing of snow production, limited water intake, etc.)
• Environmental impacts
• Ski Audits
• Negative PR
• Ranking of ski resorts
• Financing of
– infrastructure
– operational business
• Fluctuation of occupancy
• Low skiing demand</td><td>Pain relievers
• Higher spatial resolution, improved weather forecast (higher forecast accuracy)
• All-season tourism
• Compensation payments (donation per ski lift ticket sale)
• Using green electricity etc. -> compensation</td></tr>
</table>