



**CATÓLICA
LISBON**
BUSINESS & ECONOMICS

THE FUTURE OF WINTER SPORTS TOURISM IN THE ALPINE REGION OF AUSTRIA

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Dissertation submitted in partial fulfilment of requirements for
the MSc in International Management at
the Católica Lisbon School of Business and Economics

Thesis written under the supervision of André de Almeida Pinho

31.12.2019

*THE MOUNTAINS
TO BE MOVED ARE
IN OUR CONSCIOUSNESS*

Reinhold Messner

Abstract

Title: “The future of winter sports tourism in the Alpine region of Austria”

Author: Lea Müller

Keywords: winter sports, climate change, global warming, scenarios, scenarios winter sports, temperature increase, snow-reliability, skiing

Global warming is one of the greatest threats to winter sports tourism in the Alpine region. The influences of rising temperatures caused by climate change pose severe impediments for winter sports tourism. This rise in temperature results in an increase in the snowfall line and thus a decrease in the natural snow-reliability. The present thesis focuses on the effects which disruptive global warming is currently causing on the winter sports industry in the Austrian Alps and draws an outlook for the industry. To this end, the effects of different temperature increases on the industry were analysed and, with the help of expert interviews, current trends in the industry were identified. Based on the analyses and expert interviews, three scenarios were derived and future perspectives presented. A positive scenario shows how the industry, through pioneering and innovative spirit, succeeds in creating a sustainable solution for the survival of winter sports. In a neutral scenario, the market participants manage to sustain the demand for winter sports tourism with a considerable amount of expenditure. The negative scenario signifies that a contraction process will take place in the industry, which will lead to a reduction in supply on the one hand and to reduced profits on the other. The number of participants forced out of the market will increase, and thus winter sports tourism ceases to exist in the long term. These future scenarios are intended to provide comprehensive support to winter sports tourism managers in their initial steps towards a more sustainable industry.

Sumário

Título: “O futuro dos esportes de inverno na região dos Alpes Austríacos”

Autor: Lea Müller

Palavras-chave: esportes de inverno, mudanças climáticas, aquecimento global, cenários, cenários de esportes de inverno, aumento de temperatura, confiabilidade da neve, esqui

O aquecimento global é uma das maiores ameaças ao turismo de esportes de inverno nos Alpes. As influências do aumento das temperaturas causadas pelas mudanças climáticas representam graves impedimentos para o setor. O aumento da temperatura resulta no aumento na linha da queda de neve e, portanto, na diminuição da confiabilidade natural da neve. A presente tese foca nos efeitos do aquecimento global na indústria de esportes de inverno nos Alpes austríacos e desenha uma perspectiva para a indústria. Para tanto, foram analisados os efeitos de diferentes aumentos de temperatura na indústria e, com a ajuda de entrevistas com especialistas, foram identificadas as tendências atuais da indústria. Com base nas análises e nas entrevistas foram elaborados três cenários e apresentadas perspectivas futuras. Um cenário positivo mostra como a indústria, através de um espírito pioneiro e inovador, consegue criar uma solução sustentável para a sobrevivência dos esportes de inverno. Em um cenário neutro, os participantes do mercado conseguem sustentar a demanda pelo turismo de esportes de inverno com uma quantidade considerável de investimentos. O cenário negativo significa que um processo de contração ocorrerá na indústria, levando a uma redução na oferta e a uma redução nos lucros. O número de participantes forçados a sair do mercado aumentará e o turismo de esportes de inverno deixará de existir a longo prazo. Esses cenários visam fornecer suporte abrangente aos gerentes de turismo de esportes de inverno em seus passos iniciais em direção ao desenvolvimento de um setor mais sustentável.

Acknowledgements

I would like to thank everyone who supported me during the preparation of my master thesis.

Special thanks go to my thesis supervisor, André de Almeida Pinho, who accompanied me during the writing process with great dedication and constructive criticism.

My greatest thanks go to my parents, who supported me not only during my master thesis and my studies but in my everyday life. I owe much of my career to your support as my closest advisors. Thank you for providing me with words and deeds, e.g. by devoting your evenings to discussing structures and scenarios of my thesis.

A big thank you goes to my proof-readers Vivi and Luca, for their linguistic skills and the gift of comprehending my line of argumentation. Thank you for searching and finding any mistakes.

Not least I would like to sincerely thank Pepe for his loving support during the not easy time of the master thesis. Thank you for the strong emotional support during my entire studies and for your composure towards my temper.

Also, a big thank you goes to my roommates. Thank you for enduring every whim and always listening to my progress of the thesis.

I thank all interview partners for their valuable contribution to this work. I appreciate the time you have invested in me.

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1 Introduction

In the Alpine region, climate change results in winters with low snowfall and massive glacier retreat. As winter tourism is one-sidedly oriented towards skiing and is therefore extremely dependent on snow, lack of snow has severe consequences for the entire winter sports industry (Steiger, 2012). Thus, climate change (global warming) represents a new challenge for winter sports as a whole.

To this day, Austrian winter sports tourism continues to record steadily rising revenues, but how long will this remain the case? Global warming and the resulting shortage of snow indicate that winter tourism is unlikely to have a profitable future (ZAMG, 2013).

How will this industry react to changing conditions? This thesis identifies future perspectives for the Alpine winter sports industry.

1.1 Problem statement

Global warming is one of the greatest threats to the winter tourism destination of the Alps (UN-WTO, 2018). In the course of this work, global warming therefore embodies the disruptor of the winter sports industry.

The Alpine region is particularly sensitive to global climate changes as the rise in temperature here is almost twice as high as in a global comparison. Consequently, the Alps are therefore repeatedly referred to as a climate early warning system. In recent years these effects have been increasingly felt: on the one hand by climatic measurements and calculations, on the other hand by a rise of visible consequences, e.g. in the form of natural disasters (Formayer & Kromp-Kolb, 2009).

The greatest obstacles to winter sports tourism caused by climate change are the influence of the snowfall line caused by the rise in temperature, the change in precipitation, the decrease in natural snow-reliability and, as a result, the reduction in snow cover (Scott, Hall, & Stefan, 2012). Skiing and winter tourism are still inextricably linked and suitable snow conditions are an essential prerequisite in most regions (Abegg, 2011). Less snow means that fewer tourists are expected to visit the region, and the winter sports industry will suffer a severe blow. As a result, less profitable ski resorts might be phased out of the market. In many places, however, climate change may be countered to a large extent with forward-looking strategies.

1.2 Relevance

Tourism is an essential economic pillar in Austria and in the period after the Second World War the domestic tourism industry has gained an important position in world tourism. In terms of international tourism arrivals, Austria had a market share of 2.22% in 2017 and was thus among the top 15 regions in the world (Wirtschaftskammer Österreich, 2019a). Winter sports are an important part of tourism and represent the holiday brand “Austria” worldwide. The natural environment factor “Alps” has made a significant contribution to the region’s long-term success. The total value added of tourism calculated on the basis of model calculations amounted to € 30.5 billion in the reporting year 2017. The sector has thus made a constant contribution to GDP of 8.2% since 2015 (Bundesministerium, 2019).

Winter sports tourism is not a sector covered by economic statistics of its own and is therefore a "cross-sectional matter" from the hospitality industry, sports and entertainment services, retail trade, and some transport services (Arbesser et al., 2008). Winter sports enthusiasts using mountain railways generate gross sales of approximately € 7.9 billion¹. This results in an added value of more than € 4.3 billion (contribution to GDP) (Wirtschaftskammer Österreich, 2018a). Due to its significant cross-sectional outreach, changes in winter sports tourism have far-reaching effects.

The purpose of this thesis is to provide a structured overview of the future prospects of the winter sports industry, contributing to the added value for management by analysing likely scenarios on how stakeholders can respond to climate change. Managers can refer to this work to make the necessary adjustments for a sustainable business.

Since this topic is very specific to the Alpine region, a forecast for the future of winter sports in this region cannot yet be found in the literature. For this reason, this thesis aims to shed light on the specific subject of climate change in the Alpine region and its future development.

¹ Including cable cars, accommodation, gastronomy, sports shops, transport, etc.

1.3 Research questions

Snow in particular is essential for conducting winter sports. Due to the decreasing natural snow security and the resulting shorter winter seasons, it will be imperative to no longer rely solely on snow in the future and to find new tourist offers for the winter season. This consideration raises the question to which extent the prevailing climate change is already affecting the winter sports tourism.

In order to effectively address the emerging challenges caused by climate change and the questions that arise in this context, this thesis will be structured on the basis of two research questions:

Research question 1:

**How is climate change impacting the winter sports tourism
in the Alpine regions of Austria?**

Research question 2:

**What likely form will this industry take in the future,
once the impact of the disruptors is played out completely?**

2 Literature review

2.1 Winter sports tourism in the Austrian Alps

The term winter tourism refers to tourism that takes place during the winter months and is spatially located in the mountains or hilly terrain with snowfall. Nearly all these activities are dependent on snow and ice, which is why they are referred to as winter sports tourism. The most important economic sector hereby is Alpine skiing, which includes classical skiing as well as snowboarding and carving. The focus of this work lies in the field of winter sports tourism and on those regions that are largely dependent on it. (Hoy, 2008, pp. 6–7)

The Alps cross Austria from west to east and cover approximately two thirds of the country's surface area (Geographisch-Kartographisches Institut Meyer, 1997, pp. 28–29). The mountain range does not only shape the landscape but is also a core basis for the country's economy as it represents the country's most important natural resource for tourism (Statistik Austria, 2019a). In particular, winter sports tourism is strongly determined by the mountains. At the same time, tourism in the Alpine regions affects the evolvement of rural areas and functions as the motor of regional development. (Opaschowski, 2002)

The first ski tourism emerged in the Alps at the beginning of the 20th century. Today's ski tourism, however, differs significantly from its earlier form (Figure 1). Until the Second World War, ski tourism was of very little significance, as skiing was initially regarded as a sport that was only possible for the upper class. (Luger & Rest, 2002) Solely with the introduction of the World Cup races in St. Anton and Kitzbühel as well as the World Championships in Innsbruck in 1933, skiing started to gain popularity (Luger & Rest, 2002). Thus, the winter season experienced a great upsurge in the second half of the 20th century, shifting away from the niche product and becoming widely-popular throughout society (Steiger, 2012).



Figure 1: Zürs am Arlberg 1926 (Österreichischer Skiverband, 2008, p. 112)

Along with winter tourists and skiers, infrastructures such as cable cars and snowmaking facilities were introduced to the Alps.² This upswing in winter tourism is reflected in the development of mountain railways. (BMVIT, 2003) In 1957 there were 358 mountain railways in Austria, whereas in 1969, only 12 years later, five times as many were available (BMVIT, 2003). Today Austria counts more than 3,000 mountain railways, which transport 599 million people annually (Wirtschaftskammer Österreich, 2018a).

During the winter season of 2017/18, Austria welcomed over 54.6 million Skier Days per year (i.e. daily entry per person in skiing area), resulting in Austria being one of Europe's market leaders. With around 3,000 installations, the Austrian cable cars are the general service providers on the mountain - for winter and summer. (Wirtschaftskammer Österreich, 2018a) Due to its 228 ski areas Austria has the advantage to offer every guest the suitable ski area according to one's needs. This spectrum ranges from the largest connected ski area Arlberg with luxury chalets directly on the mountain to smaller and more affordable family ski areas. Besides, there is an extensive offer of cable cars and pistes, as well as accommodation and off-piste programmes in the regions. (Wirtschaftskammer Österreich, 2018a)

2.1.1 Market structure of winter sports tourism

In the 2017/18 winter season, Austrian winter tourism generated sales of approximately € 14.1 billion, which exceeds the revenues of the summer season (€ 12.7 billion) and exhibiting a constant increase (Statista, 2018). Winter sports continue to be the most important mainstay of domestic winter tourism. More than 80% of winter sales are generated in the Alpine region. (Wirtschaftskammer Österreich, 2018a)

In the Alpine region, state winter tourism strategies still focus on the further development of winter sports (Smeral, 2010). However, some states employ a two-pillar strategy, which is primarily aimed at strengthening winter sports tourism while spreading risk through diversification. On the one hand, the ski resorts will receive support for quality improvements, including artificial snowmaking as well as new and high-altitude ski resorts. On the other hand, the second pillar represents the encouragement for the development of snow-independent products. (Bausch & Unseld, 2018) For instance, communities and organisations in small ski resorts are thus eligible to receive subsidies (Wirtschaftskammer Österreich, 2019c). In general, the Austrian tourism industry is determined by its fragmented structure of small and medium-sized

² The opening of the first cable car in Austria took place in 1926 (Wirtschaftskammer Österreich, 2018a).

family businesses. Particularly the Bavarian Alps, the Austrian Alps and South Tyrol are characterised by an exhaustive tourism structure and a large number of tourist resorts with a comparatively small number of guest beds. (Bätzing, 2003, pp. 160–161) This fragmentation is mainly evident in the distribution of beds by type of accommodation. In winter 2017/18, hotels and similar establishments accounted for 56% of beds, while private accommodation accounted for 26% and other accommodation (holiday flats and houses for commercial purposes, children's and youth recreation centres, youth hostels and guesthouses, huts and other tourist accommodation) for 17%. (Wirtschaftskammer Österreich, 2019a)

2.2 Disruptor: Global warming

The climate of a place or a region is understood to be the "average weather", i.e. the composition of the weather on the earth's surface in a fixed period of time, more precisely a thirty-year reference period (WMO, 2019). This is needed to determine the characteristics of statistical weather data. The climate is not a state but is constantly changing due to natural processes and external factors³. Climate change is therefore the statistically significant change in these average values established in the reference periods. The difference to climate variability lies in the repeated occurrence of previously anomalous events. (WMO, 2019)

In order to be able to record future developments and changes in the climate system, complex climate models are being developed to calculate and predict such future trends (Pachauri et al., 2014). The strongest input in this respect is provided by the Intergovernmental Panel on Climate Change (IPCC), which was founded in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). The IPCC is an intergovernmental body that establishes the link between science and politics (IPCC, 2019). The IPCC Special Report outlines the current situation of global warming and the human contribution in this regard.

The total warming refers to the actual temperature change, regardless of the origin, while the human-induced or anthropogenic warming refers to the component of this warming that can be traced back to human activities. With the global temperature currently rising by 0.2°C (±0.1°C) per decade, man-made warming reached 1°C above the pre-industrial level around 2017 (1850-1900 pre-industrial reference period) and, if this rate of warming were to continue, would reach

³ External processes are largely caused by humans, which is why they are often referred to as anthropogenic climate change (WMO, 2019).

1.5°C by 2040. (IPCC, 2018a) The effects of climate change are felt on all inhabited continents as well as in the oceans. Yet they are not uniformly distributed across the globe, and different parts of the world experience varying manifestations. Temperatures averaging 1.5°C across the globe pose an increased risk of heat waves, heavy rainfall and many other possible environmental impacts. (IPCC, 2018b) The current efforts to keep global warming at 1.5°C depend to a large extent on the influence of the current nationally determined contributions (obligation of the nation states to a specific greenhouse gas emission), which only extend until 2030 and do not limit global warming to 1.5°C. (IPCC, 2018a) The heating of +4°C above pre-industrial temperatures until the year of 2100 is thus dependent on the reduction decisions after 2030 (UNFCCC, 2016). It can be assumed that without further climate measures, i.e. business-as-usual, global warming could reach up to 4°C. In order to cover laid out climate developments, climate scenarios of +1°C, +2°C and +4°C global warming will be analysed in the course of this thesis.

2.3 Winter sports and climate change

Climate change is already exerting a strong impact on the global economy. This applies to changes in production cycles and harvest days, but also to increasingly more frequent environmental phenomena such as droughts and floods. (Gallina et al., 2016) Tourism is therefore affected as a sector of the economy as a whole, and winter tourism in the Alpine regions in particular will be severely affected by climate change and its repercussions. Causes of the impact of climate change lie in the rise in temperature and the change in precipitation. The interaction of these two factors rises the natural snowfall line, the natural snow-reliability decreases and the winter season is shortened. (Gilaberte-Búrdalo, López-Martín, Pino-Otín, & López-Moreno, 2014) The consequences of climate change for winter sports tourism in Austria are hence far-reaching.

2.3.1 Climate change in the Alpine region

The effects of climate change, calculated in global climate models, cannot be directly transferred to the Austrian Alps, as there is a multitude of interactions with different spatial and temporal scales. The results must therefore be adapted to the respective region using different methods. (Kromp-Kolb & Formayer, 2001) However, even with regionalisation, the research can lead to disproportionate results for the very complex Alpine region. The calculations and the expected changes vary greatly from region to region across the studies, as the respective

conditions and sites of a region are dealt with. Thus, models examining the Austrian Alpine region were developed. (Agrawala & OECD, 2007) These models provide an indication of the trends and changes that can be expected in the winter: temperature rises, changes in precipitation (quantity and local shift) and reduction of the natural snow-reliability or reduction of the natural snow cover (Kromp-Kolb & Formayer, 2001).

With a length of 800km and a width of 200km, the Alps lie in the transitional area between the Atlantic Ocean, the Mediterranean Sea and the large Eurasian continental mass. This situation entails interactions of continental and oceanic effects in winter and also varying influences of the moisture reservoirs of the Mediterranean Sea and the Atlantic at different climatic conditions and seasons, making climate-relevant assessments particularly difficult. Additionally, the Alpine mountains with their highest peaks between 4,400m and 4,800m above sea level and their average altitude of 2,500m represent a striking obstacle for inflowing air masses. (Wanner, 2000, pp. 31–32)

The Alps react very sensitive to climate change which is mainly due to the fact that the snowfall line, forest line, lawn line and permafrost line can shift upwards or downwards even with minor changes. Hence, the Alpine region plays an important role in the anthropogenically intensified greenhouse effect and the resulting global warming (Haubner, 2002, p. 8). The long-term decreasing trend of snowfall is overshadowed by strong fluctuations lasting up to approximately 20 years. These fluctuations are associated with increases in snow or extreme decreases. Due to these strong natural fluctuations, statements on snow trends are only meaningful with time series of about 50 years or more for the Alpine region. Only then can the natural fluctuations be distinguished from the long-term changes caused by human-induced global warming. (ZAMG, 2017)

2.3.2 Snow-reliability

Snow-reliability as an economic indicator

The literature provides various definitions of snow-reliability. From a ski tourism perspective, the so-called 100-day rule has prevailed. In its original version, the rule states that an economically sensible investment in winter sports areas is only achieved if, among other things, the installed facilities can be expected to operate for at least 100 days per season, which is only possible with a snow cover of sufficient thickness (Witmer, Filliger, Kunz, & K ung, 1986). However, this definition is considered to be vague and needs to be clarified before it can be applied in practice. For example, the minimum snow depth required and the definition of the ski season (100 days in the period from ... to ...) should be defined. (Abegg, 2012) In addition, it raises the question of whether the 100-day rule should be complied with every winter or bad years can be compensated by good ones, which would correspond more to reality, i.e. only 7 out of 10 winters have to comply with the 100-day rule. (Abegg, 1996) There are researchers that refer to a snow-reliable ski area if sufficient snow cover of at least 30-50cm for skiing is obtained for at least 100 days in 7 of 10 winters between December 1st and April 15th. Given that the 100-day rule is met, it is assumed that the conditions for a successful ski operation are favourable (B urki, 2000, p. 42). Research suggests using the 100-day rule as an indicator for assessing the profitability of a ski resort (Witmer et al., 1986). However, this approach is contradicted in the literature. While a sufficiently thick layer of snow over a longer period of time is an important prerequisite, it is not considered to be the only factor determining the success or failure of a ski area. In this sense, the 100-day rule is also accepted by numerous ski resort operators in Europe and North America. (Scott, Dawson, & Jones, 2008) The 100-day rule has developed into a valuable instrument for the analysis of natural and technical snow-reliability (without or with consideration of technical snowmaking) (Abegg, 2012). Occasionally, the 100-day rule is supplemented with further indicators: the ‘‘Christmas indicator’’ (Scott et al., 2008) and the ‘‘Season start indicator’’ (Steiger & Abegg, 2013). The purpose of these additional indicators is to analyse particularly critical periods in depth. An early start of the season - in good conditions - has a positive impact on the image of the ski resort, the sale of season tickets and the booking behaviour of customers. The Christmas season is critical because many ski resorts generate more than 20 percent of their winter turnover in the short period over Christmas and New Year. (Abegg, 2012)

3 Methodology

For the purpose of answering the research questions of this thesis, primary research through expert interviews and secondary research based on literature, as well as analyses and presentation of statistical data were applied as working methods. In the course of this work, a literature review was carried out, which creates a theoretical basis for further research. The focus lies specifically on winter sports tourism in Austria, global warming and climate change in the Alps.

Further insights were gained through six semi-structured expert interviews (see details on experts in Figure 2). Insights provided by experts from the Austrian winter sports industry identified challenges and drivers with regard to future winter sports as well as possible alternatives. The interviews were conducted with the help of guiding questions. The interview partners are representatives of the respective identified stakeholder group (ski lifts, hospilities, tourism-related businesses and winter sports enthusiasts) and were selected based on the degree of involvement in the industry, in terms of macro- and micro-perspective. In the macro perspective, emphasis was placed on choosing partners who were expected to have a generic view of the issues. To gain an insight into the micro-perspective, persons who are specialists in their field were selected, taking their reputation as experts in their respective discipline as a criterion.

The secondary research was used to gather information from various official sources, e.g. Wirtschaftskammer Österreich. The analysis of quantitative data is carried out in several chapters. Statistical data was collected from different databases, primarily from Statistik Austria and StATcube. This is followed by a written interpretation and discussion of the results. An analysis was carried out regarding the effects of climate change-related alterations in temperature increase on overnight stays and arrivals. In addition, guest behaviour was analysed using statistical values such as overnight stays and length of stay. Based on the development of the interplay between the number of overnight stays, length of stay, the temperature conditions and current trends for example, the behaviour of the stakeholders was examined, and a derivation of a potential future reaction was elaborated.

In order to answer the first research question, part of the thesis aims to provide an overview on existing and measurable effects of climate change on the industry while assessing their development and severity. The answer to the first research question is therefore divided into two chapters (4.1 and 4.2). Current trends of the industry are elaborated for gaining an understanding of present movements of the industry. Based on assumptions, scenarios for the future of the

winter sports industry in the Alpine region will then be developed, thereby answering the second research question (chapter 4.3).

Interview partner	Occupations	Degree of involvement in the industry
Müller, Christoph	deputy head of ski school Züers am Arlberg (Vorarlberg)	micro-perspective of a winter sports related business
Muxel, Ludwig	mayor of Lech/ Züers am Arlberg (Vorarlberg) for 26 years	professional expertise with the issues of winter sports dependent businesses as well as the economic macro-perspective of a winter sports destination
Manhart, Michael	<ul style="list-style-type: none"> - board member of Rüfikopf Seilbahn AG, managing director of Bergbahn Lech-Oberlech and Rud-Alpe Gastronomie GmbH - former managing director of Stubner Fremdenverkehrsgesellschaft m.b.H and Auenfeld-Jet Seilbahn Ges.m.b.H. & Co. KG, and second managing director of the ski lifts Schröcken - performed important pioneering work, especially in the field of environment and snowmaking as well as avalanche protection - manager of numerous projects concerning high-altitude greening and renaturation as well as the revitalisation of protection forests - involved in snowmaking on the Arlberg since the 1970s and installed the first snow cannon in this area 	<ul style="list-style-type: none"> representation of micro-perspective of several skilift companies high degree of involvement in <ul style="list-style-type: none"> - environmental issues on the mountain-site - artificial snowmaking
Jochum, Gebhard	<ul style="list-style-type: none"> - hotelier of a 5-star hotel in Züers am Arlberg (Vorarlberg) - seat on the supervisory board of Rüfikopf-Seilbahn AG and Skizüers AG and member of the management board of Bergbahnen Stuben - former head of the Züers Tourism Association for many years, member of the advisory board of Lech/ Züers Tourism and of the municipal council and the construction committee of the municipality of Lech 	expertise in the hospitality sector of a winter sport destination and knowledge about the interactions of several stakeholders in a winter sports resort
Fercher, Hermann	managing director of Lech/ Züers Tourismus	know-how about the entire tourism industry and its developments on site, and a future strategic orientation for winter sports destinations
Schröcksnadel, Markus	<ul style="list-style-type: none"> CEO of the company Skitour - operates mountain railway companies such as ski slopes, gastronomy, hotels and ski rentals - supplies IT systems for tourism (incl. reporting systems, card systems, booking machines and marketing systems for ski resorts, supplying information systems and acquiring advertising sponsors for ski resorts) 	insight in strategies and operations of several ski resorts and therefore enabling a foresight and generic view on the industry

Figure 2: Details on interview partners

4 Findings and discussion: Future prospects for winter sports tourism

4.1 Climate-induced consequences for the Austrian Alps

4.1.1 Natural spatial consequences

A consortium of meteorologists, climate researchers and academics have developed the impacts of climate change for Austria on behalf of the federal government and the federal states. (Fleischhacker, 2018) The following paragraph describes the natural spatial consequences for Austria relevant to this work.

Climate change leads, among other things, to a shift in vegetation zones, a change in the composition of species and a reduction in species diversity is also presumed. (Fleischhacker, 2018) Further, the retreat of the glaciers is set to continue. Glacier areas react sensitively to higher temperatures, especially in summer. By the end of the 21st century, a further drastic decline in summer snowfall is expected in the three-thousand-metre-peak region. (ZAMG, 2013) This event will significantly change the Alpine landscape, which in Austria is characterised by more than 900 glaciers at altitudes between 2100m and 3800m. (Fleischhacker, 2018) The resulting melting of glaciers uncovers permafrost soils, i.e. soils that only thaw superficially in summer (Kuhn, 2005, p. 40). An upward movement of the permafrost base due to climate change is to be expected, whereby the increase may run parallel to the increase in air temperature. The thawing of permafrost in high-alpine regions is associated with increasing fall processes (massively greater risk of rockfall), which can have a particularly negative impact on Alpine hiking trails and via ferratas. (Fleischhacker, 2018)

However, not only the thawing of the permafrost can trigger rockfall, but also extreme temperatures or extreme weather events. Heavy precipitation can cause floods and mudslides or dangerous hillside movements and avalanches in winter. Thus, as climate change progresses, the number of natural disasters is likely to grow. (Fleischhacker, 2018)

Moreover, climate change also affects precipitation. During the summer months, a decrease in precipitation frequency is anticipated - the frequency of "fair weather periods" increases. (Fleischhacker, 2018) Due to the rise in temperatures, a more frequent occurrence of heat days and longer heat spells is to be reckoned with. Therefore, in hot summers, particularly higher Alpine areas with a pleasantly "cool" climate would benefit. (Fleischhacker, 2018)

4.1.2 Changes in temperature and effect on snow conditions

The most important parameter for winter sports tourism is snow, which is closely related to air temperature (ZAMG, 2013). In climate models, temperature is regarded as the most reliable parameter that predict further warming of the Alpine region from the middle to the end of the century (ZAMG, 2017). However, the rise in temperature has triggered varying reactions at different altitudes. (ZAMG, 2013)

Prognoses for the future development of snow conditions are particularly relevant at altitudes where there is a direct correlation with temperature. Thus, at altitudes below 1000 to 1500 meters, it can be assumed that the snow cover will continue to decrease in the long term. (ZAMG, 2017) In the high mountains, by contrast, it is usually cold enough for snowfall in winter as it is. In this case, snow levels depend more on precipitation and thus, on weather conditions. (ZAMG, 2017) Table 1 shows which researchers have addressed this topic for the Austrian Alpine region.

Scholars	Research area	Findings
Breiling & Charamza (1999)	Statistical model on temperature, precipitation and snow cover	At an altitude of 2,000 m, a temperature rise of up to 2°C with no change in precipitation would have no major consequences for the ski resorts, but at middle altitudes a rise of only 0.8°C would have serious consequences.
Agrawala & Organisation for Economic Co-operation and Development (2007)	Cross-country study on temperature effect on snow-reliability of the Alpine areas (Austria, Germany, Switzerland, Italy, France)	91% of Alpine ski areas resulted to be naturally snow-reliable. With a temperature rise of +1°C, +2°C, and +4°C would reduce the areas to 500, 404 and 202, respectively (without snowmaking).
Steiger (2011)	Importance of artificial snowmaking to reduce the effects of climate change on ski resorts feasibility	With a temperature rise of +2°C, the potential number of days with optimal conditions for producing artificial snow (humidity and temperature conditions) will be reduced by 33%.
Steiger (2012)	Importance of artificial snowmaking to reduce the effects of climate change on ski resorts feasibility	Ski resorts are less dependent on natural snow (conditions) due to improved snowmaking techniques.
Steiger & Abegg (2013)	Effects of climate change on winter tourism in Austria by means of -the 100-day rule -ski season beginning December 8th -availability of sufficient snow during Christmas holidays	43% of a total of 228 ski areas met those three criteria (reference period 1961-1990). With a temperature rise of +1°C,+2°C and +4°C, snow-reliable ski areas would reduce to 81%, 57% and 18%, respectively (with snowmaking). With a temperature rise scenario of +2°C, more than 50% of ski resorts have to increase snow production by 100-199%.

Table 1: Overview of studies concerning temperature rise in Austria (Agrawala & OECD, 2007; Breiling & Charamza, 1999; Steiger, 2011, 2012; Steiger & Abegg, 2013; Steiger & Mayer, 2008)

The most referenced research work hereby is the study concerning the natural snow-reliability line by Agrawala & OECD (2007).

Two different climate zones prevail in the Alps, implying a variation of snow-reliability in the different areas. The Eastern Alps of Austria exhibit a continental climate, whereas the Western Alps of Austria (as in the Swiss part of the Alps) are predominated by an Atlantic maritime climate. (Wielke, Haimberger, & Hantel, 2004) This yields different baselines of 1,050m for Eastern Austria (where there are colder winters) and 1,200m for Western Austria (Agrawala & OECD, 2007, p. 31).

It is assumed that the snow-reliability line will rise by 150m per 1°C temperature increase (Abegg, Agrawala, Crick, & de Montfalcon, 2007). Consequently, at an altitude where the current snow-reliability line is 1,050m, this line will rise to 1,200m in a temperature rise scenario of +1°C. In the scenarios of +2°C and +4°C, the snow-reliability line ascends further to 1,350m and 1,650m respectively. Analogously, the snow-reliability line rises at the threshold of 1,200m and 1,500m (the latter is not relevant for Austrian ski resorts). Austria's 228 ski resorts are located within 7 of the 9 federal states at altitudes between 1,050m and 1,200m (Table 2). (Agrawala & OECD, 2007, pp. 30–31)

Altitude of natural snow-reliability line	Federal states	Ski areas	Snow-reliable under present conditions	%
1,050 m	Salzburg	39	35	90%
	Styria	37	34	92%
	Lower Austria	13	9	69%
	Upper Austria	11	7	64%
1,200 m	Tyrol	79	75	95%
	Vorarlberg	25	19	76%
	Carinthia	24	20	83%
> 1,500 m	n.a.			
Total		228	199	87%

Table 2: Snow-reliability of ski areas in the Austrian Alps (following Agrawala & OECD, 2007)⁴

In this study, the 100-day rule is applied according to which region is considered snow-reliable; that is, if, on average, at least 100 days a year a closed snow cover of more than 30cm is given at medium altitudes of the ski area (OECD, 2006). This analysis also takes into account that some ski resorts have a lower situated locality and the ski facilities are in the higher locations of the area. Thus, a ski resort is considered snow-reliable if the upper half of its area is above the thresholds for natural snow-reliability. (Agrawala & OECD, 2007, p. 31) For example, the

⁴ For more detail, Appendix VI Table 7.

village of Kitzbühel is located at approximately 700m, but the highest peak in the ski area is at just under 2,000m. Accordingly, this ski area is above the thresholds of 1,200m (500m are below and 800m above the threshold).

Considering the data on snow-reliability of Austrian ski resorts, it appears that approximately 87% of ski resorts can currently be classified as snow-reliable (Table 2) (Agrawala & OECD, 2007, p. 31). More concretely, this implies that at the present temperatures, 13% of all ski resorts in Austria have already fallen below the thresholds and effectively can no longer operate without technical snowmaking (Table 2).

The analysis defies the widespread assumption that lower-lying ski resorts will be more affected by global warming and proves that conclusions on the prevalence of higher ski resorts drawn by Fleischhacker (2018) can be premature. The increasing natural snow-reliability line in connection with the two climate zones in Austria shows that the ski resorts in Tyrol and Lower Austria, in particular, will perform worst, already at a 1°C warming, as 18 and 11 ski resorts respectively will drop below the snow-reliability line (Figure 3, Appendix VI Table 7 and Table 8). This represents a deterioration of 19% and 78% respectively from the present situation (Appendix VI Table 9).

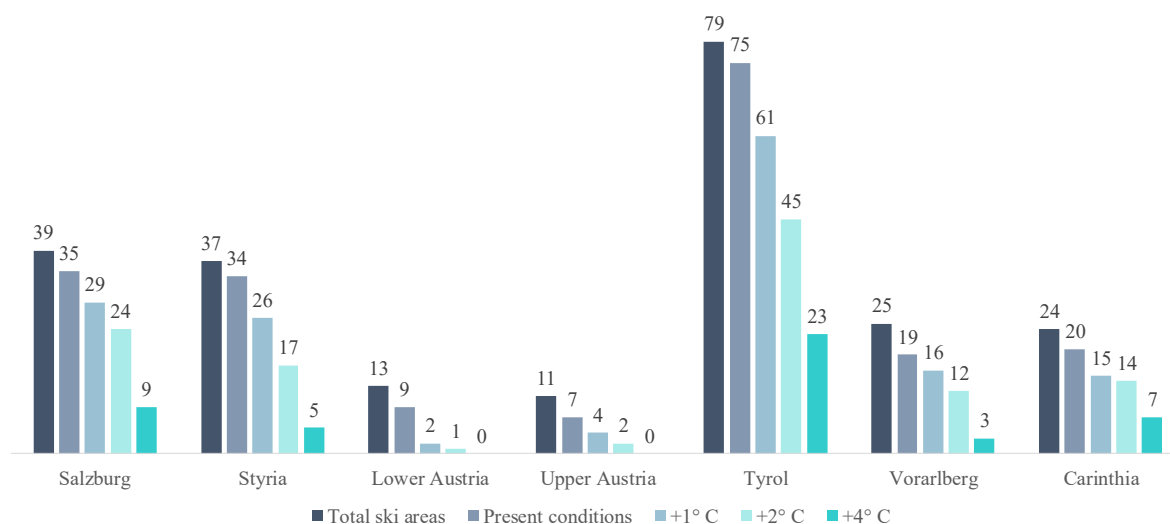


Figure 3: Temperature scenarios of snow-reliability of ski areas in the Austrian federal states (following Agrawala & OECD, 2007)⁵

In the case of a +4°C temperature increase, the number of naturally snow-covered ski resorts in Austria would shrink to 47 ski resorts, a reduction of 79% (Appendix VI Table 7). Figure 4

⁵ For more details see Appendix VI Table 7.

illustrates that in Lower and Upper Austria, not a single ski resort could be operated with purely natural snow. In Tyrol, the federal state with the highest number of ski resorts, a reduction of 56 ski resorts (compared to total ski areas) is assumed to take place (71%). However, in these scenarios it must be taken into account that only the natural snow-reliability line was considered. Ski resorts located below this line can therefore continue to operate using technical snowmaking (as long as the conditions for snowmaking allow it).

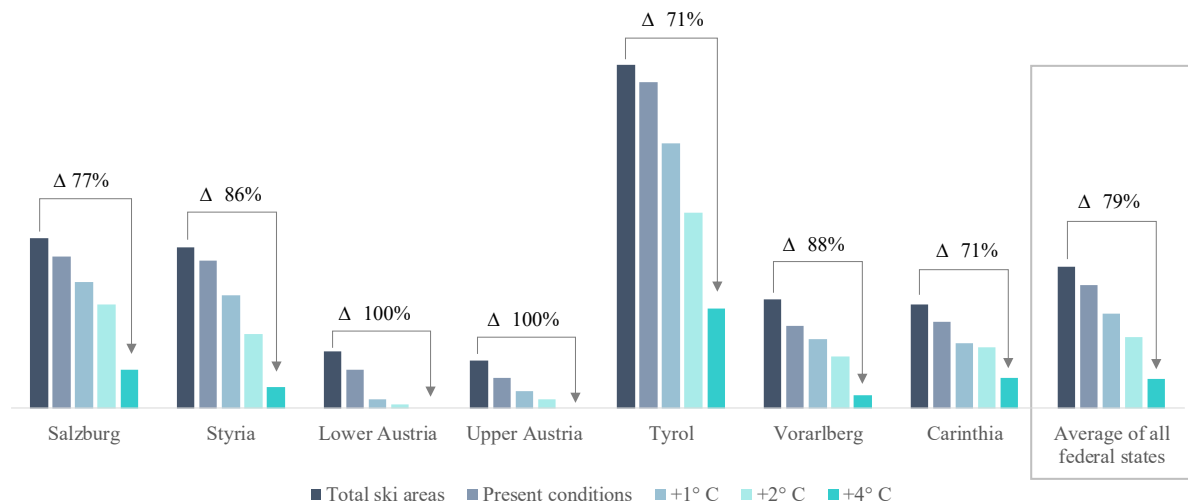


Figure 4: Change of snow-reliable areas comparing the scenario of +4° C to the total ski areas in Austria (following Agrawala & OECD, 2007)⁶

Analysis

Calculating the average for all federal states in the various scenarios gives a representative picture of the situation in the respective federal states. On average, only 87% of ski resorts are snow-reliable under the present conditions (Appendix VI Table 7). Additionally, the number of ski resorts decreases by an average of 33%, 50% and 79%, depending on the scenario (Figure 5).

⁶ For more details see Appendix VI Table 8.

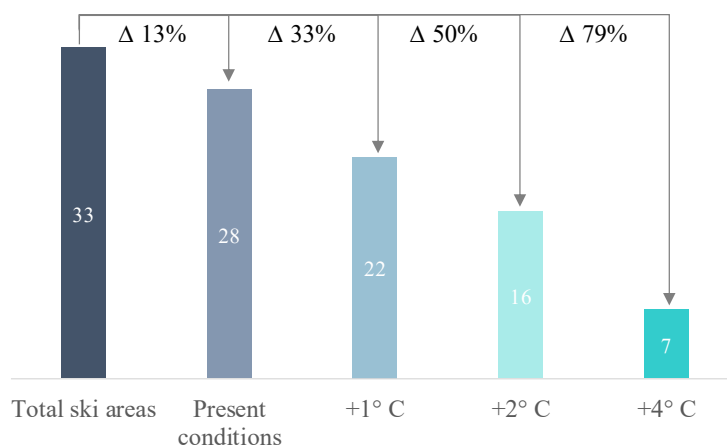


Figure 5: Average reduction of snow-reliable ski areas in the federal states by temperature scenarios

The monetary effects of the reduction of natural snow-reliable areas are reflected, for example, in the additional costs of artificial snow production. Figure 6 shows that a temperature increase of +4°C would cost € 118.5 million for technical snowmaking (excluding construction and modernization).

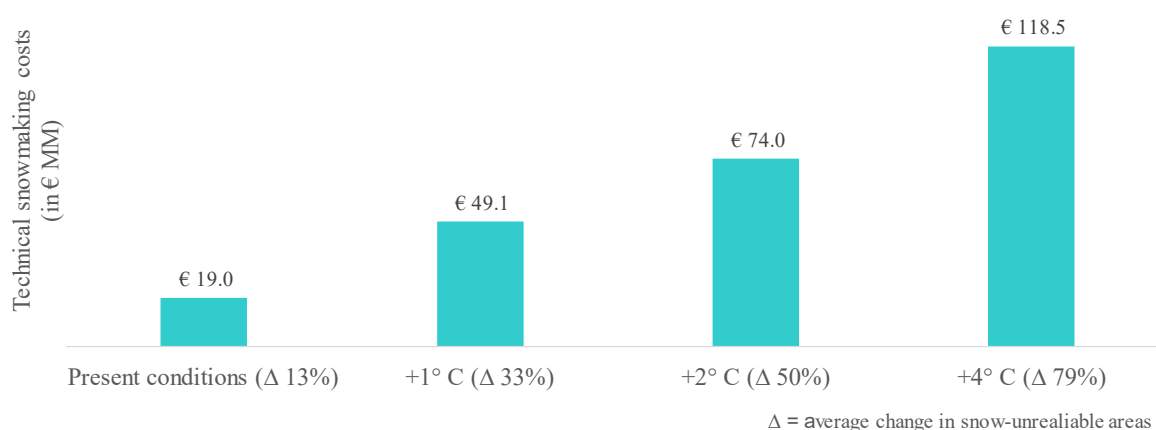


Figure 6: Impact of temperature increase on technical snowmaking costs depicted by the temperature scenarios⁷

For the calculation of the snow production costs, a range of € 2-4 per cubic metre of snow was used (Schröcksnadel, fd). The calculation is based on the assumption that a snow height of 30cm is produced (OECD, 2006). The calculation includes the information of the cable ways reports stating that 70% of Austria's ski pistes can currently be covered with snow (Wirtschaftskammer Österreich, 2018a).

⁷ For the detailed calculation and assumptions see Appendix VI Table 10.

Using the indicator "natural snow-reliability", the predicted effects of climate change can be translated into economic consequences, i.e. the reduction of arrivals and overnight stays in tourism as well as turnover in the region. The assumptions used entail calculations on winter sports tourism which assume that around 12% of all arrivals and 23% of all overnight stays in Austria are attributable to active or passive winter sports tourism (Arbesser et al., 2008). Applying these assumptions to the forecasted effects on snow-reliability, the number of arrivals in Austria at risk due to climate change amounts to approximately 2.7 million (+2°C scenario) and 4.3 million (+4°C scenario) respectively (Table 3). Accordingly, the potential decline in overnight stays in Austria ranges from 17.2 million to 27.6 million (Table 3). The calculation is based on 44.8 million arrivals and 149.8 million overnight stays for the entire calendar year 2018 (Statistik Austria, 2019b).

Arrivals 2018 (in MM)		44.8		
Winter sports		12%		
Share		5.4		
Scenarios	Number of ski areas	Reduction	Arrivals (in MM)	Loss of arrivals (in MM)
+1° C	153	67%	3.6	(1.8)
+2° C	115	50%	2.7	(2.7)
+4° C	47	21%	1.1	(4.3)
Overnight stays 2018 (in MM)		149.8		
Winter sports		23%		
Share		34.8		
Scenarios	Number of ski areas	Reduction	Overnight stays (in MM)	Loss of overnight stays (in MM)
+1° C	153	67%	23.3	(11.4)
+2° C	115	50%	17.5	(17.2)
+4° C	47	21%	7.2	(27.6)

Table 3: Effects of temperature increase on arrivals and overnight stays of winter sports tourism by temperature scenarios

Another assumption is made based on the calculation that every third euro spent by domestic and foreign tourists in Austria can be attributed to winter sports (Arbesser et al., 2008). Hence, winter sports tourism currently generates € 9.1 billion with 228 ski resorts, which corresponds to a percentage of 4% (Appendix VI Table 11).

Based on this percentage, the losses of the climate scenarios are computed. In the +1°C scenario, 153 ski resorts generate a turnover of € 6.1 billion. This represents a loss of € 3 billion. By analogy, a loss of € 4.6 billion is calculated with 115 ski resorts (+2°C scenario) and a loss of € 7.3 billion (+4°C scenario) with only 47 ski resorts (Figure 7).

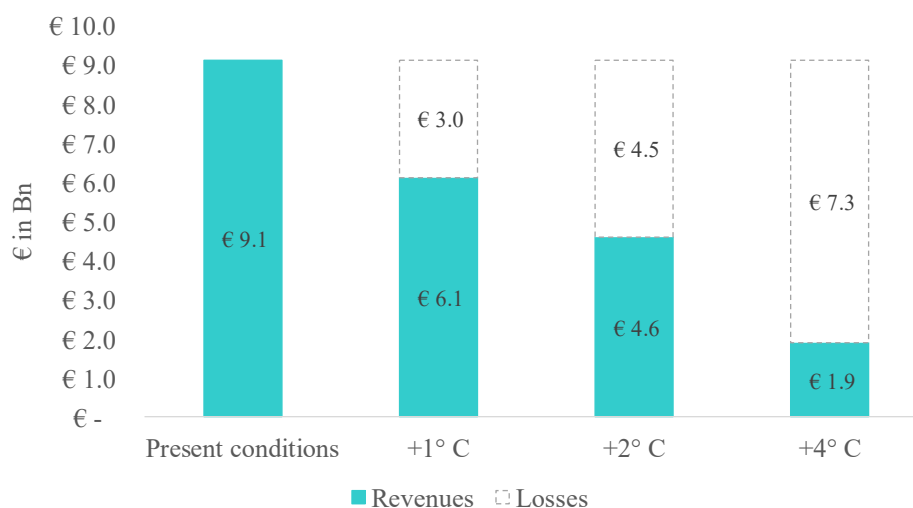


Figure 7: Monetary impact of temperature scenarios on the turnover of winter sports tourism due to tourism income from domestic and foreign guests⁸

These calculations are based on the hypothetical assumption that the ski resorts will not be artificially snowed. Although this does not correspond to practice, on the one hand, it reflects the monetary effect of climate change more effectively and on the other hand, it underlines the necessity of artificial snowing. Furthermore, it is assumed for simplification that the ski resorts are all relatively the same size and therefore generating relatively equal turnover.

The crux of future scenarios

According to expert scenarios, a temperature rise of +2°C until 2100 is currently forecasted for the Alpine region (AlpNet e.V., 2016). Thus, warmer temperatures will generally be expected in the long term, although there is no concrete research consensus on degree, speed and regional impacts for Alpine winters. Particularly for the near future (2030), the location-dependent conditions of winter sports, such as temperature, precipitation and duration of the snow cover, cannot be anticipated. (AlpNet e.V., 2016) Future scenarios of climate models tend to show more precipitation in winter, which could even lead to more snow in the high mountains. (ZAMG, 2017) Therefore, neither temperature nor precipitation are determined as parameters to create a reliable and meaningful climate scenario for the future.

⁸ For the detailed calculation see Appendix VI Table 11.

4.1.3 Conclusion of climate-induced consequences for the Austrian winter sports tourism

Based on the elaborated findings of the previous chapters, the first research question posed at the beginning can be answered by this point of the thesis.

<p style="text-align: center;">How is climate change impacting the winter sports tourism in the Alpine regions of Austria?</p>

The changes caused by global warming are increasingly reflected in various phenomena in Austria, such as changes in vegetation, melting of glaciers, thawing of permafrost, natural hazards, change in precipitation and hot spells. The various studies and publications on global climate change and climate change in Austria come to different conclusions, but they all predict an increase in temperature. As a result, the natural snow-reliability line is predicted to increase by 150m per 1°C warming. Accordingly, the amount of snow is expected to decrease in lower locations as well as in intermediate locations (considering the climate zones). At the same time, the conditions for snowmaking will become more difficult due to increased temperatures (Manhart, ci). Initially, all these aspects influence tourism regions at low or medium altitudes.

When the limit of natural snow-reliability rises further, the underlying ski resorts are faced with major challenges. As the climate scenarios for overnight stays and arrivals demonstrated, the changes caused by climate change can have a profound impact on the (tourism) economy throughout the country (e.g. already a +1°C warming reduces turnover by € 3 billion). The reduction of turnover in winter sports tourism affects both accommodation and gastronomy in Austria's Alpine skiing regions. Summarising the elaborated climate scenarios, it can be concluded that the ski season will tend to become shorter in the future and the need for financing necessary infrastructure such as snowmaking facilities will continue to increase.

Consequently, the endangered ski resorts are forced to take measures that counteract the effects of climate change. First and foremost, this is carried out with snowmaking equipment. But in the upcoming years, it is worth considering whether it makes sense to invest in these slope areas. Artificial snow is a measure that does not promise a successful future when temperatures rise. This is due to the fact that snowmaking facilities are dependent on certain temperatures as well. Thus, snowmaking is not the ultimate solution and is only a transitional measure.

Climate change is not a continuous process but is associated with extreme weather conditions. As the interviews revealed, tourism managers do not directly attribute snow-poor winters to

climate change and are of the opinion that improved snowmaking equipment can compensate for such weather phenomena. Thus, the long-term consequences of climate change have not yet been recognised in their full extent by those responsible for tourism.

4.2 Trends evolving in the winter sports industry

The concluding response to the first research question is extended by the following trends and developments in the industry.

4.2.1 Competition for the difference in altitude

The development of higher locations for skiing purposes represents a strategy that is currently being pursued very intensively by some winter sports regions. This includes the expansion of ski resorts as well as new developments and mergers of ski resorts. (Güthler, 2003, pp. 9–10)⁹

4.2.2 Investments

There are several aspects that determine competitiveness in the winter sport industry. The variety of ski runs in terms of length and steepness, piste maintenance and snow cover are decisive for a ski resort. Additionally, a ski resort has to create a social atmosphere where entertainment is guaranteed, and a sense of affiliation is created. The accessibility and travel time of a ski resort can also set it apart from other ski resorts. (Fercher, ee) For Austrian winter sports enthusiasts, sufficient snow cover is the key decision criterion for a ski resort. Therefore, the majority even accept 10% additional costs as well as a 2h longer journey time. (Unbehaun et al., 2008)

With the installation of snowmaking facilities the trend of decreasing numbers of guests has been diminished (Töglhofer, Eigner, & Pretenthaler, 2011). The calculations in chapter 4.1.2 highlight the importance of technical snowmaking.

Artificial snowmaking has performed an enormous development which required a considerable amount of money. Figure 8 shows the course of the investments of the cable car companies from 2007 to 2018.

⁹ The context of the following topic is more extensively elaborated in Appendix I.

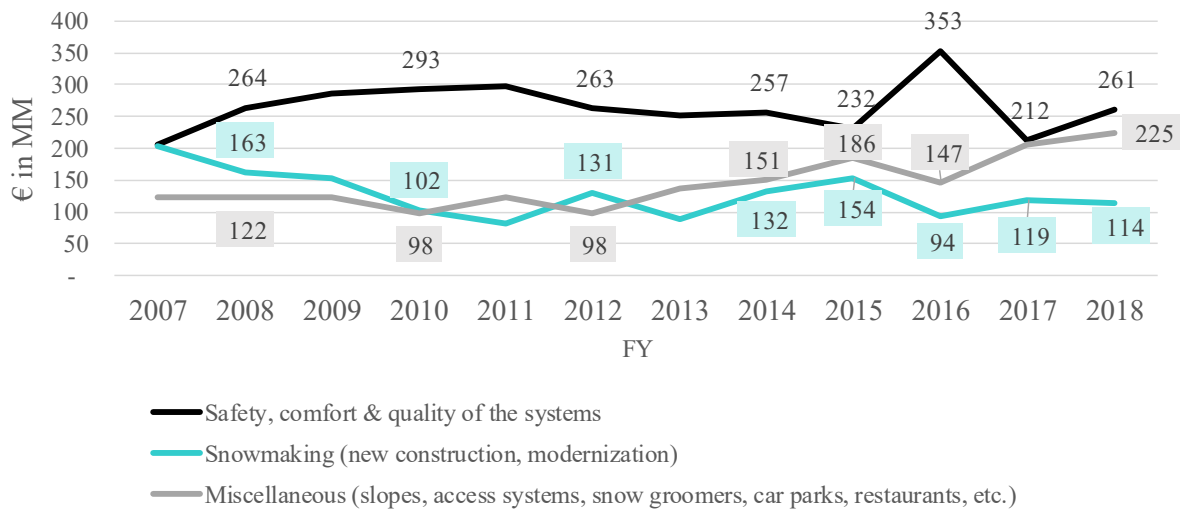


Figure 8: Development of investment areas of cableways of FY 2007–2018 (Wirtschaftskammer Österreich, 2019d)¹⁰

In the 2017/18 season, cableway companies generated €1.4 billion in cash turnover with 253 cable cars. To ensure this strong driving force of winter tourism is maintained, more than € 6 billion have been invested in snowmaking technology, modernisation and increasing comfort in ski resorts since 2006 (in Figure 8 all lines combined). (Wirtschaftskammer Österreich, 2018b) By now, over 70% of all Austrian ski pistes can be covered with artificial snow and thus guarantee snow-reliability with almost 90% of all energy used deriving from renewable sources (Wirtschaftskammer Österreich, 2018a). This pronounced investment behaviour stems from the circumstance that the local hoteliers are often co-owners of the mountain cable car companies and are therefore interested in the further development and quality improvement of an area. (Schröcksnadel, fh)

After the University of Natural Resources and Life Sciences Vienna verified that the vegetation does not suffer any damage from snowmaking and that the areas can be renatured, many representatives of ski resorts have taken a positive stance towards snowmaking. (Manhart, ci)

4.2.3 Target group(s)

Renaissance of summer tourism

Regarding the sun's strength, climate change in the Alpine region is reaching levels similar to that of the Mediterranean sun in the past (Borkmann et al., 2017, pp. 40–41). Thus, mountain

¹⁰ For more figures see Appendix VI Table 12.

sports in the summer experience a positive effect of climate change, as more visitors are attracted to the Alps by sunny days (Schröcksnadel, fa).

Although in times of globalisation holiday destinations compete with destinations all over the world, summer tourism is very much in focus (Jochum,db, dd). Social life is shifting from the overheated metropolises to the somewhat cooler mountain regions (Borkmann et al., 2017, pp. 40–41). The area also benefits from the fact that hiking has become a popular activity among young people (Muxel, bg). 40 years ago, hiking with parents had not enjoyed a good reputation among youths. Today the Alps are the fashionable travel destination of the youth and inspire them with extreme experiences and original nature adventures. The connection to nature has become a whole new lifestyle. (Schröcksnadel, fb)

Shifts in the catchment area

Western Europe, and especially the German source market, has always been the main source market of the Alpine countries (Borkmann et al., 2017, p. 43). Domestic demand remains particularly strong (Figure 9), although currently, a shift from the German source market to the Central and Eastern European markets can be noticed (Borkmann et al., 2017, p. 43). Demand also has become much more international in recent years. New source markets, such as the Asian market, have led to a wide mix of nations among guests who are rediscovering Alpine winter sports. (Schröcksnadel, fc)

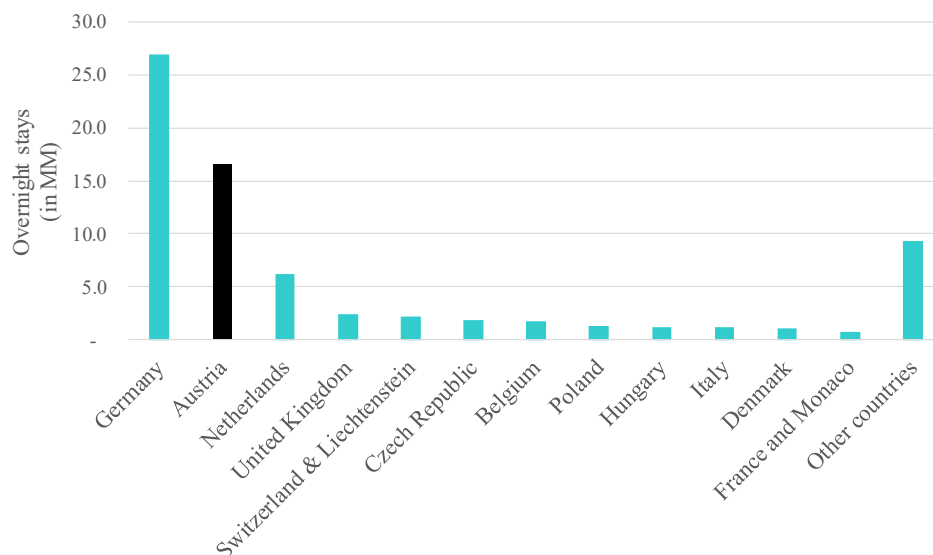


Figure 9: Most important countries of origin due to overnight stays in the winter season 2018/19 (STATcube, 2019a)¹¹

¹¹ For more figures see Appendix VI Table 13.

This change is viewed critically by experts, as Austria lies in the midst of the richest countries in the world. Regarding the catchment area of the guests, the ski resorts should concentrate on these neighbouring countries and not pursue strategies to acquire guests from Asia who have to cover a long flight. (Schröcksnadel, fc) Besides, travellers from Western Europe offer the highest demand potential for the upscale hotel industry, especially people aged 50 and over (Borkmann et al., 2017, p. 42).

4.2.4 Guests behaviour and expectations¹²

A Delphi study with 33 experts from academia and practice, found skiing to be the most important offer of winter sports until at least 2030 (Figure 10). Further, winter experiences in harmony with nature, such as winter hikes, are becoming increasingly popular. (AlpNet e.V., 2016)

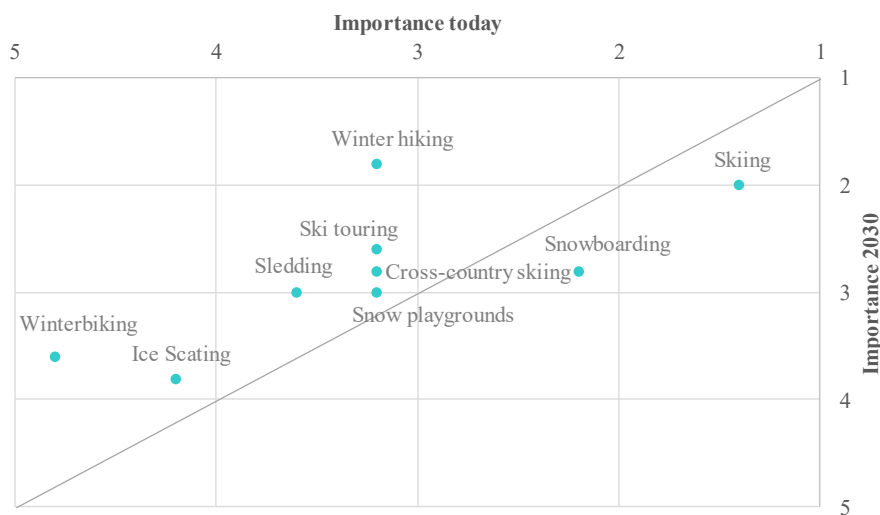


Figure 10: Importance of winter sports offers in 2016 and 2030 [5-1, least to most important] (following AlpNet e.V., 2016)

A study by Bausch & Unseld (2018) found that especially guests like non-skiers expect a wintery landscape and an environment that contributes to relaxation.

4.2.5 Four- or two-season tourism

The tourist winter season runs from November to April and the summer season from May to October respectively. In the 2018/19 winter season, 72.9 million overnight stays were registered

¹² The context to the following topics is more extensively elaborated in Appendix II.

throughout Austria, an increase of 1.5% on the 2017/18 season (Figure 11) (STATcube, 2019b). A major part of these overnight stays, about 56.4 million, are due to foreign guests. The remainder, 16.5 million, are accounted for by domestic tourists. Accordingly, the share is 23% domestic tourists to 77% foreign tourists. Of these 77%, about half come from Germany (48%). (STATcube, 2019a)

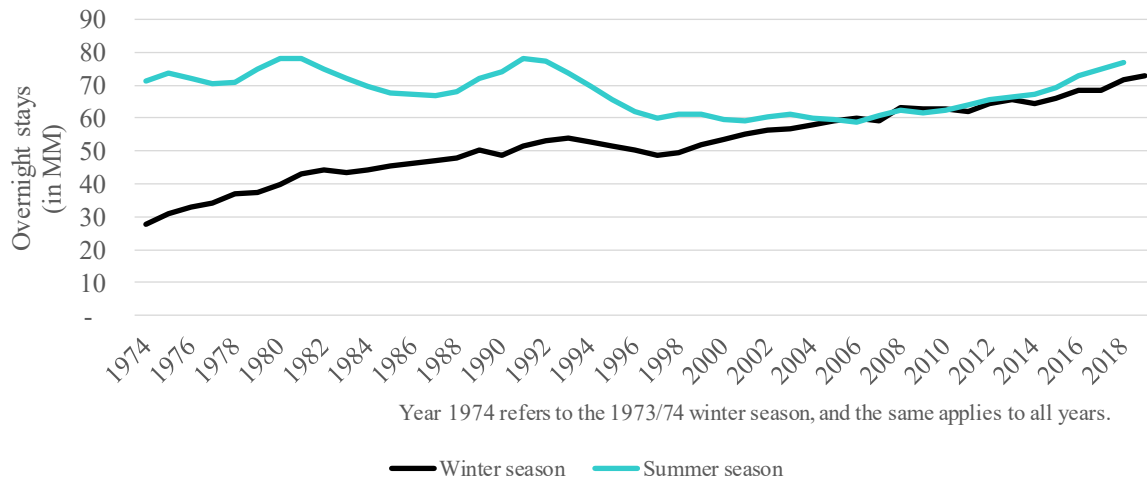


Figure 11: Overnight stays by summer and winter season from 1973/74–2018/19 (STATcube, 2019b)¹³

Figure 11 illustrates that tourism is constantly gaining in importance for the entire Austrian tourism balance in the winter season. The number of overnight stays in winter has risen steadily, in contrast to the summer season, which has maintained a rather static, at times even declining, demand volume. In 1990 the overnight percentage of winter and summer was still about 40% to 60% (approximately 49 million to 74 million). 10 years later, the proportion shifted to 47% to 53% (approximately 53 million to 60 million). In the winter season 2005/06 the number of overnight stays exceeded that of the summer season for the first time. Since then, the proportions of the overnight stays have generally been 50 to 50%, with summer tourism usually leading by a few percentage points. Hence, the figures from the tourism year 2017/18 show an overnight percentage of winter and summer of 48% to 52% (71.8 million overnight stays in the winter season, 76.7 million overnight stays in the summer season). (STATcube, 2019b) This implies, that the domestic tourism has been constantly growing; only the seasonal distribution has changed. The 2018/19 winter season yielded the best result of all, both in terms of overnight stays (an increase of 1.4%) and arrivals (an increase of 3.1%). (Statistik Austria, 2019b)

¹³ For detailed figures see Appendix VI Table 14.

Climate change has a largely negative effect on winter holidays, but increasing temperatures also offer advantages in summer (Alber et al., 2011). The temperature scenarios regarding snow-reliability show that regardless which scenario will occur, winter tourism will be at risk in the future. One way to avoid total dependence on winter and snow tourism is to establish a four-season tourism system. This means that the predominant one-sided tourism season should be extended. The aim is therefore for those regions that will be severely affected by snow shortage in the future to prolong their tourist season and consequently reduce their dependence on snow and winter. This will make it possible to better utilise the infrastructure, some of which is very capital-intensive. The winter sports regions could thus compensate for a poorer winter business with increased marketing of the summer season. Besides, climate change in particular is playing a positive role in summer tourism. The increased "fair weather periods" (as mentioned in chapter 4.1.1) favours nature-consuming activities, so-called "outdoor activities" by summer guests.

Accordingly, many regions have expanded the summer operation of cable cars in recent years. The summer offer also includes seminar and congress tourism, educational tourism, health tourism and spa tourism. Attractive offers in the mountains, such as summer tobogganing, paragliding, culinary delights or high ropes courses, can further increase the number of cable car passengers. For instance, the ski resort Lech/ Zürs endeavours not only to develop summer tourism, but also spring and autumn tourism. In the summer, emphasis is placed on cultural programmes. The area also benefits from an increase in the number of hikers in the mountains. (Muxel, bg) A case in point is provided by the Brandnertal ski area in Vorarlberg, which currently has a summer/winter tourism ratio of 60/40, compared to 30/70 in the past (Müller, ad).

Scrutinizing this possible solution, it is worth noting that not every winter sports resort is suitable for year-round tourism. The geographical, topographical and infrastructural conditions are decisive for the success of this kind of tourism. For example, Zürs am Arlberg, at an altitude of 1,700m, has the best chances of success as a pure ski resort. Lower locations, such as Kitzbühel or St. Anton, however, are in better positions to diversify their offer. (Jochum, db)

4.2.6 Generation problem and its effects

Four of the six industry experts surveyed report about a generation change that is currently taking place, primarily in hotel operations. Traditionally, ski resorts thrived due to frequenters. For example, 80% of the guests at the 5-star Hotel Lorünser in Zürs am Arlberg are frequenters

who already book on departure for the coming season (Jochum *dc*). Due to the shift of generations and the associated handover of the hotel operators, this is now slowly changing. The booking behaviour of the guests, which has shifted from weekly to daily bookings, indicates that loyalty is decreasing, and guests are no longer personally attached to a specific hotel. (Müller, *ab*) The change in booking behaviour is also reflected in a change of length of stay per guest. In contrast to the number of overnight stays, the length of stay has been constantly decreasing since the 1973/74 season averaging less than 4 nights per guest (Figure 12).

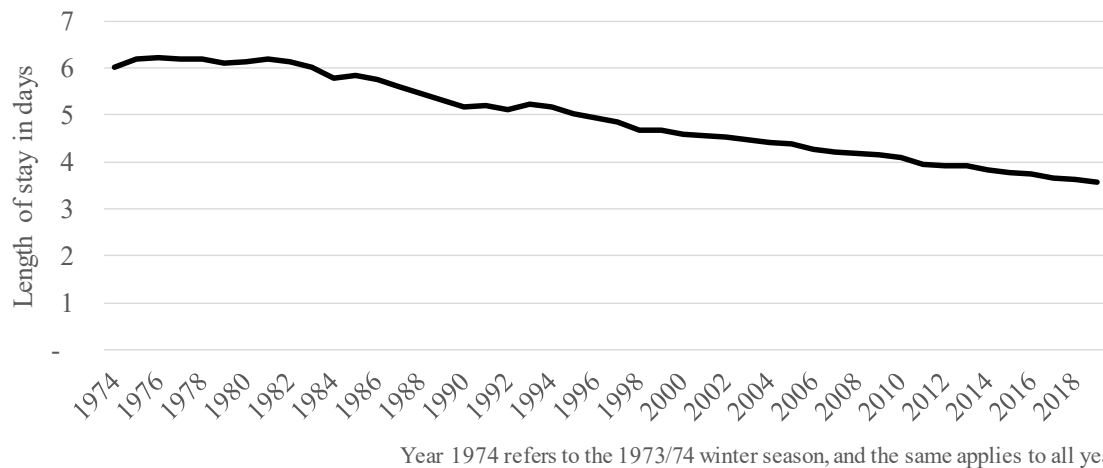


Figure 12: Decreasing length of stay¹⁴ during winter seasons since 1973/74 (STATcube, 2019b)¹⁵

The rising number of overnight stays in combination with the declining length of stay per guest suggests that the number of guests (arrivals) in the Alpine region is increasing in winter. The rising numbers (arrivals and overnight stays) of winter sports contradict the negative forecasts discussed in section 4.1. Accordingly, guest acquisition poses no peculiar problem, but rather the change in the winter sports product portfolio.

4.2.7 Climate neutrality

Human behaviour influences environmental change in many ways. In winter tourism, the journey to the destination and the accommodation is generally managed by motorised private transport. However, due to its harmful contribution to the carbon footprint of tourism, there is an urgent need for clean energy technology. (Nagaich, 2018) For this reason, innovative mobility solutions between smart cities and winter sports resorts represent a high-potential, untapped

¹⁴ Length of stay = overnight stays/ arrivals

¹⁵ For more figures see Appendix VI Table 15.

niche. Specifically, in the Austrian Alpine region, 90-95% of all guests come from a catchment area within the range of 500km. Thus, they largely resort to independent arrivals, resulting in the possibility of travelling by public transport. Consequently, Austrian ski resorts have the potential to become holiday destinations that offer high compatibility with the climate targets. (Schröcksnadel, fa)

Concepts to promote renewable energies, the use of energy-saving technologies and innovations to minimise resource consumption are measures that have already been implemented in some regions today. Alpine architecture is already largely consistent and sustainable. Villages such as Lech/ Zürs am Arlberg, for instance, counteracted the negative effects of climate change at an early stage and were thus able to preserve the typical landscapes of the region. (Muxel, bi)

The maintenance and sustainable development of the landscapes were just as relevant as the preservation of Alpine biodiversity and landscape protection areas. The Arlberg region provides a best-practice example, where the prevailing landscape was taken into account in land use determination. Spatial development as well as transport and mobility development and aspects in agriculture and forestry are equally central components of this issue. (Manhart, ce).

Traffic management

At regional or local level, traffic management involves, on the one hand, traffic calming through car bans (car-free areas), temporary traffic restrictions (night driving bans), speed limits, traffic guidance systems or parking management (parking spaces collected at one point, often outside the villages). On the other hand, the public transport network can be expanded to reduce the number of guests using their car during and for their winter holidays and to facilitate alternative means of transport. This includes the development of a network of footpaths and cycle paths as well as the improvement and optimisation of bus and train connections within and between towns. These measures can be supported by the provision of baggage and pick-up services (e.g. from train stations or out-of-town parking), shuttle services from hotels to lift stations or incentives to travel by train (through reduced ski day tickets or hotel arrangements when using the train). Some of these traffic management measures have already been implemented in the Lech/ Zürs region (Appendix bi).

Energy management

An important point with regard to reducing the greenhouse effect is the use of renewable energies, such as solar, hydro and wind power, geothermal energy and biomass. In many Alpine

regions there is a very high solar radiation, which can be used by solar collectors and photovoltaic systems for energy production. (Manhart, ce). The generated energy can then be used in various areas such as hotels, tourism businesses or cable car facilities. Reservoirs can serve as a water supply for snowmaking as well as for electricity generation. An example on implementations of energy management is provided by Lech/ Zürs (Appendix bi).

4.2.8 Conclusion of trends and developments

With the consideration of winter sport specific trends alongside the gained insights on climate change effects, research question 1 can now be answered conclusively.

<p style="text-align: center;">How is climate change impacting the winter sports tourism in the Alpine regions of Austria?</p>

Fundamentally, the trends due to the influences of climate change comprise two aspects. On the one hand, the behaviour of consumers (guests), on the other hand, the behaviour of the various providers on the tourism market.

For guests, the trend is turning towards authentic experiences "returning to nature", provided that their own experience of nature does not interfere with nature itself.

On the part of the providers, the trends lean towards the application of innovative solutions to compensate for existing external influences (weather phenomena). Several possibilities are considered, ranging from the substitution of snow by artificial snowmaking to alternative winter sports (winter hiking, dog sledding, etc.) and alternative hotel concepts. Efforts to offset the cost pressure are undertaken by larger organisations, with a focus on mergers and collaborations.

The influence of climate change on winter sports tourism is reflected in the weather conditions, particularly snow conditions, becoming increasingly unpredictable. Thus, snowy winters with chaotic snow events alternate within a very short time with winters with little snow or winters that are much too warm (ZAMG, 2013). To compensate for this, attempts are being made to invest in infrastructure, involving extensive artificial snowmaking such as reservoirs and alternative offers in the hotel industry. Furthermore, there is already strong predatory competition between the high-altitude tourist resorts and the lower ones. This leads to increased efforts to expand summer tourism, especially in lower locations. In fact, summer arrivals in Austria are already higher than winter. However, the current strategies to counter climate change will often

not be the final response to climate change, as they often only have a medium-term impact. In the long term, the ultimate approach is still being sought.

The results of the last winter seasons indicate that winter sports tourism is still prospering (chapter 4.2.5). Nevertheless, the positive performance of the industry in combination with the prioritisation of market participants on short-term effects over medium to long-term consequences can lead to an economic collapse as soon as the disruptor is fully deployed. Consequently, market participants will have to act more actively in the future.

4.3 Future scenarios of the industry

In this chapter, three potential scenarios for the winter sports industry are developed. The three scenarios are directed towards answering the second research question.

**What likely form will this industry take in the future,
once the impact of the disruptors is played out completely?**

For this reason, the scenarios are categorised as positive, neutral and negative. These terms refer to the result of these future scenarios, i.e. the future of winter sports either follows a positive, neutral or negative course regarding its viability.

For the time being, all three scenarios are weighted with the same probability of occurrence of 33.3%. These probabilities of occurrence are modified at the end of this chapter based on the insights of the expert interviews and personal assessment. All three scenarios are based on the same premise assuming the worst-case, a global warming of +4°C, i.e. the disruptor has fully spread. Climate change is the disruptor in this work and is therefore not included as an influencer. The scenarios are based on the different behaviours (mainly proactive or reactive) of the stakeholder groups and are divided into primary and secondary roles. Secondary stakeholders respond by nature reactively to changes in the environment. The division into primary and secondary stakeholders was determined on the basis of the insights gained from the interviews.

Stakeholder groups	Role	Detailed description
Ski lifts	Primary stakeholder	Ski lift operators (including piste operators)
Hospitalities	Primary stakeholder	Hotels, bars, restaurants and mountain huts
Tourism-related businesses	Secondary stakeholder	Service providers such as ski schools, ski and accessory rentals, sports shops, doctors and sanatoria
Tourist association	Secondary stakeholder	Providing tourist information Responsible for the marketing to specific target groups Representative of the municipality's interests as a public transport provider
Winter sports enthusiasts	Secondary stakeholder	Traditionally: skiers, snowboarders, cross-country skiers and touring skiers

Influencers	Role	Detailed description
Civil movements	Influencer	Movements such as "Fridays for Future" (Greta Thunberg)
Politics	Influencer	Including - local/ national politics - national environmental laws - international environmental treaties
Technology	Influencer	Concerning - winter sports - snowmaking - mobility

Table 4: Description of the stakeholders and influencers in the winter sports industry

4.3.1 Future scenario “POSITIVE”

Targeted cooperation in tourism destinations is the driving force behind the development and implementation of future strategies. Such a cooperation can take place with mergers of several companies in tourism, for which there are already examples in the industry such as the American Vail Resorts (Jochum, dg). To remain competitive in the long term, the ski resorts of the Alpine region are developing a management structure with a common vision and strategy, a so-called Destination Management Organisation (DMO). The tasks of the DMO differ depending on the region and the respective framework conditions. Tourism destinations in the Alps are transforming into professional companies in the form of public limited companies, developing the entire product (hotels, mountain railways, etc.) from a single source. The currently individually operating companies form large entities with uniform management structures and professional financing methods (e.g. private equity money, external investors). This increases equity and counteracts the formerly high level of debt financing.

Newly created supra-regional cooperation models are put into practice in order to provide guests with offers that meet their needs. The focus is on expanding the range of sports that can be practised in the mountains in winter alongside or instead of the classic winter sports. Above all, investments are being directed at alternatives to snow, such as mats, halls, or the exploitation of the cold night-time through night skiing. Investments are also made in snowmaking. However, the emphasis is on innovative solutions for the better and more efficient use of technology through optimal exploitation of weather conditions without wasting natural resources. Completely new product formats are being developed where snow no longer plays a central role and is only seen as part of the landscape (as opposed to skiing). The main task lies in the coordinated, joint approach of the actors and in innovation management. In addition to product development and product management, the scope of these DMOs also includes the design of an environment that is worth living in for both locals and new residents to ensure the basic conditions for tourism.

Cooperation can take place on several spatial levels, from local to regional. Synergies can be created not only in marketing activities, but also in the area of facilities (e.g. snow groomers, snowmaking plants), as well as personnel, infrastructure and know-how (e.g. on snowmaking technology). The investment activities are coordinated centrally, and the costs are distributed to all participants. Thus, the most distinguished destinations are going to prevail: the best winter

resorts, the most international hotspots, the most traditional mountaineering villages and the most renowned health destinations.

To steer the winter sports industry in this direction, a proactive primary stakeholder is needed to initiate this upheaval. The ski lift companies are in the best starting position, as they often run more than simply the ski lifts and pistes, but also a few restaurants, etc. The ski lifts therefore define the legal structures for the DMOs. The hospilities enter into cooperation, as they see a lot of potential within the DMO structures to reduce their costs and address their guests in a more targeted way. The range of such a DMO depends on the respective winter sports destination. Potentially, these can include not only tourism related business, but also hairdressers, doctors, sanatoria, etc. and accordingly verticalize the entire value chain. The DMO can orient itself strategically, taking local conditions into account. These orientations range from four-season tourism, to various hotel programmes (sports hotels, health hotels, etc.) to cultural programmes. Depending on the respective orientation, further tourism-related businesses enter the market in the form of e.g. cultural institutions.

The DMOs are conducting strategic investments related to a smart infrastructure. The aim is to make the arrival of guests more ecological and comfortable whilst at the same time prevent uneconomic and unecological individual journeys. The main focus is on expanding the public transport network of arrivals and departures, especially for trains (500km radius). Until the technology produces further solutions, electrified shuttle buses carry the guests to the individual final destinations. The coordination of such strategic operations is carried out by the tourist association. Targeted marketing activities also lie in the area of responsibility of this coordinator. This includes the handling of the target group(s) and the addition of further customer segments (e.g. culture lovers, eco-conscious persons, health patients, etc.). In this scenario, the catchment area will settle within a radius of 300-500 km. Thus, a climate-neutral journey can be guaranteed. The ski regions and DMOs pursue different positions in order to maintain their competitive edge. This is achieved by means of different orientations such as health, sport, culture, wellness, families, adventure holidays or even a combination of everything provided there are favourable conditions. The winter sports enthusiast welcomes this structural change in winter sports destinations. While some regions are more interested in summer or cultural programmes, destinations whose topographical and climatic conditions allow it, specialise in winter sports, but at the same time offer a broad alternative programme if the conditions for winter sports are temporarily poor.

Some influences outside of the industry become noticeable as well. Civil movements such as "fridays for future" by Greta Thunberg exert pressure on the industry to make climate-neutral investments. Politicians are reacting proactively and creating structural framework conditions that, above all, include legal foundations to facilitate the creation of cooperation such as DMOs. Politicians further support the industry by granting tax concessions for investments in new winter sports activities. Moreover, investment incentives in the form of free investment allowances, reduced depreciation periods and a better tax rate for reinvested undistributed profits reinforce industry growth. Technological progress is also significantly contributing to the development of the industry as an important influencer, affecting the industry by creating new means of transport for the journey to the mountains and enabling the innovation of new winter sports.

4.3.2 Future scenario "NEUTRAL"

In the winter sports industry, ski lifts represent the market participants with the highest funds of capital. Historically, ski lifts have always been the driving force behind innovation and advancement in the industry. In the neutral future scenario, these companies try to counteract the effects of climate change with innovations in artificial snowmaking technology. However, this costly venture is ultimately passed on, directly or indirectly, to all stakeholders. This can take place in either the form of a direct financial charge on the hospitalities, or in the form of levies paid by each market participant to the tourist association and new municipal taxes. In some cases, the costs are passed on via the winter sports enthusiasts, who have to pay a higher ticket price. The latter eventually entails an indirect allocation to the hospitalities, as some hotels include the ski tickets in their packages and thus bear the costs themselves.

The hospitalities seek to satisfy guest wishes with individual programmes. This will range from spa programmes to alternative programmes for skiing. Due to the fragmented structure of the industry and the already existing over-indebtedness - especially in the hospitality sector - large mergers of several companies are barely feasible. The hospitalities are therefore merging to form "soft" cooperation whereby the ownership structure remains fragmented. Similar hotel types e.g. sports hotels or 5-star hotels try to address similar target groups to have a wider reach, implying that target groups such as Asian skiers can also be considered. Due to the investment costs for snowmaking or replacement formats as well as snow substitutions and the associated costs for all stakeholders, tourism related businesses also face higher costs. These companies

are responding with a more flexible business structure, broadening their product range and increasing their prices as a result. In a company like the ski school, for example, this means that a ski and snowboard instructor no longer only skis and snowboards with the guests but is also available as a mountain trainer/entertainer for all kinds of mountain activities. The tourist association embodies a platform which is responsible for the financial redistribution of the investment costs in the ski area.

The marketing of the tourist association focuses mainly on the promotion of the region as a winter sports destination and addresses target groups who have no possibility to practice winter sports in their surroundings. Examples include the Sierra Nevada or the Pyrenees, where classic winter sports are no longer viable due to climate change, or China and other regions of the world, where ski tourism is relatively new and little established. Winter sports enthusiasts, who are passionate about this sport, spare no expense and effort and keep skiing in the Alps. Classic winter sports such as skiing, or snowboarding is becoming an expensive exclusive sport that young people in particular can no longer afford. This inevitably results in the Alps no longer being the number one destination for many winter holidaymakers. Winter sports tend to decrease accordingly. As such, guest behaviour implies that the opportunities for younger generations to learn skiing decrease, thus creating even greater problems for the next generation. Above all, the largest target group, the guests from the immediate vicinity of the Alps, continues to decrease due to rising prices. The arrival from more distant destinations is only possible by plane and thus sheds additional unecological light on winter sports, which already suffer from a negative image due to the encroachments on the mountain scenery (lift, road and piste construction), as well as the wasteful use of water (snowmaking). The aggressive investment in artificial snow machines and unecological tourism in the Alps is negatively opposed by civil movements due to the waste of natural resources such as water for snow production. Many people find it ever more difficult to justify a holiday that involves wasting so many resources while the actors are not working on a better ecological image.

Due to the changing natural conditions in tourism and the expected deterioration, many participants in winter tourism encounter more or less severe financial difficulties, which is why politicians intervene. In most cases, it is the in-deficit cable car companies that are dependent on monetary support. They form the backbone of the winter tourism offer in a region and are therefore of great economic importance. The objective of the financial measures is to maintain winter sports operations with the aid of public and private funds. Winter sports regions can

receive financial support in several ways, for example through operating subsidies, direct shareholdings in cableways or the granting of favourable loans. These funds then flow into the expansion of the snowmaking systems or the renewal of the ski lifts, for example. Technology ensures the development of snowmaking systems that exploit weather conditions more efficiently due to artificial intelligence or machine learning, thus counteracting the wasteful use of natural resources. Care is taken to utilize these improvements for marketing purposes as well, in order to improve the image of snowmaking and related winter sports. Furthermore, the technology is also expected to contribute to the progress of finding a snow substitute enabling skiing to be carried out elsewhere, such as grass skiing, mat skiing (as already used in ski jumping), development of air-cushion skis, etc.

These structural developments in the industry result in winter sports only taking place in a few specialised major resorts. Small areas can no longer afford the investments and disappear from the market. Occasionally, the use of technologies extends the original winter sport into the summer. These specialised winter sports destinations remain on the market due to technological progress, such as new and automated snowmaking methods, alternative and environmentally friendly ascent facilities or alternative sports activities.

4.3.3 Future scenario “NEGATIVE”

In the last scenario, climate change affects the individual actors severely to the extent that the various stakeholders have not sufficiently developed strategies for their economic base well in advance. This assumption is made on the basis of the findings of the interviews, in which the interviewees did not consider an immediate need for action necessary. Snowmaking technology (without genuine ecological innovations) no longer counteracts the effects of climate change, mainly because the industry prefers to use its resources for R&D in more future-oriented industries. Ski lifts face the problem that funds become limited as the individual businesses were unsuccessful in sharing the costs of necessary investments among all those involved in winter sports through at least loose mergers or other arrangements. The ski lifts alone are no longer in a position to bear the high running costs of snowmaking and the necessary innovative investments alone. Therefore, they are driving a strict cost saving program, which is reflected in the reduction of the offer on the one hand. Fewer pistes and fewer lifts are operated, whereby savings can be achieved in terms of piste maintenance and snowmaking. On the other hand, the ski lifts reduce their willingness to invest and do not pursue projects concerning innovations for

e.g. snow production. As a result of these measures, ski lifts are forced to reduce their prices in order to attract more winter sports enthusiasts.

The hospilities are constrained by the dependence on the ski resort. The cost-saving programme of the ski lifts inevitably leads to a reduction in the number of guests. Some hotels are counteracting by creating alternative programmes for winter sports, but these strategic manoeuvres require a high degree of investment with the prospect of failing to generate returns. Most hospilities therefore reduce their prices and try to attract more guests to the Alpine regions with special offers. Tourism-related businesses have to take measures to reduce costs as well. This includes a reduction in the offer as well as a drop in quality, which is associated with a subsequent price decrease, leading to the gradual unprofitable development of the businesses.

Laid out stagnation of investments results in a downward spiral for the winter sports industry. The less money tourists spend in the tourism regions, the faster cost-efficient companies differ from cost-inefficient ones, as the latter quickly exit the market. The tourist association reacts to the changes in the market with a more aggressive marketing. But without innovations and with diminishing capital, winter sports are only practised by local winter sports enthusiasts - provided the weather conditions allow it. Hardly any new winter sports enthusiasts are acquired, and many people do not learn to ski at all. Winter sports generally appear in a bad light, due to the unecological management and orientation that the industry has adopted. However, summer tourism is still being welcomed, i.e. stakeholders are trying to generate more turnover from summer tourism, which means that the already reduced budget is allocated to summer tourism, accelerating the decline of winter tourism.

Politicians can only respond reactively to the downward spiral some tourism businesses have already been caught in. In view of the impending collapse of an important economic sector for Austria, attempts are now being made to keep unemployment as low as possible. Alternative jobs are being created in the Alpine regions by setting up businesses that are independent of tourism, such as wine-growing. Technologically, no further progress is to be expected in this scenario, as it lacks the necessary funds to promote innovation and the research and development of technology takes place in more lucrative economic sectors.

Winter sports are thus drastically decreasing and disappearing in the long term from the Austrian Alpine region. This development starts at lower altitudes. Regions at lower altitudes (provided they react in time and still have the necessary financial manoeuvring capital) are, in contrast to higher altitudes, in a better position to replace winter tourism with summer tourism. The high altitudes adhere to winter tourism for a longer time, but in the long run, they do not

have a chance either, as the downsizing of the offer also leads to a loss of offspring (skiers). Ultimately, many tourist destinations (both at high altitudes and lower altitudes) in the Alps cease to exist or focus exclusively on summer tourism. The result of this development will be the impoverishment of the Alpine population. Thus, the Alpine regions will become economic problem areas.

4.3.4 Scenario overview and conclusion

To answer the second research question, the scenarios are briefly summarized, and the most-likely scenario is then selected. The various actions of stakeholders and influencers are summarized in Table 5.

**What likely form will this industry take in the future,
once the impact of the disruptors is played out completely?**

In all three scenarios, a reduction in the number of winter tourism providers takes place. A sustainable chance of survival for winter sports is only provided by the *positive scenario*, in which a concentration of winter tourism becomes apparent. The *neutral scenario* represents a short- to at most medium-term scenario for the viability of winter sports tourism and therefore ski resorts. Based on the impressions gained from the expert interviews, the following assessment can be made. At present, the lower-located ski resorts are already moving towards the *negative scenario*. The higher regions still remain in the *neutral scenario*, while (a few) more innovative ski resorts are already entering the *positive scenario*. In the long run, ski areas cannot remain in the middle scenario, but either slide into the *negative scenario* (if lack of leading stakeholders and lack of vision) or manage the leap into the *positive scenario* early enough. Hence, ski resorts must be innovative and possess sufficient pioneering spirit and vision to succeed. At the same time, winter sports destinations need to be aware of the associated risks of first-moving. While one has the advantage of claiming large market shares, a first-mover can also expect high initial investments, such as in infrastructure.

The industry trends developed show that the current success factors of the Alpine region are sustainability, responsibility, adaptability, diversity and hospitality. Targeting these success factors, in combination with building on organizational characteristics such as vision and pioneering spirit, form the basis for the future. In order to ensure these values, the overall regional development of the Alps is a central prerequisite for which holistic sustainable strategies

are required. As a consequence, strategic development and high financial strength are indispensable in order to meet future requirements. For named reasons, the *positive scenario* is the most likely scenario that the industry will look like once the disruptor has fully spread. This scenario is expected to occur with a probability of 60%, while the other two scenarios are considered equally likely with a probability of 20%. The latter percentage will increase drastically in areas that have not yet participated in the boom of winter tourism and above all have little investment potential.

The question of why the individual actors make different decisions in the respective scenarios is answered by two factors: awareness and action. In the future, market participants will have to pose the question of what can be done, and by who, to ensure that awareness is achieved, and actions can follow. Whose responsibility is this? Is it the duty of the managers of the ski lifts? Or is it the residents or the mayor who need to act? When should the government intervene? What stance will the press take? Is it primarily more important to generate awareness or take actions? Or is one not feasible without the other?

Accordingly, the three scenarios represent only one way to find answers to questions like these. The response as presented in this thesis shows the need for action particularly on the part of the primary stakeholder groups, since far-reaching processes are set in motion by e.g. the actions of ski lifts or the absence of such initiatives.

Stake holders/ Influencers	Role	Behaviour	POSITIVE SCENARIO	Behaviour	NEUTRAL SCENARIO	Behaviour	NEGATIVE SCENARIO
Ski lifts	Primary stakeholder	<i>proactive</i>	<ul style="list-style-type: none"> - Cooperation (DMO) - Classic winter sports are substituted or supplemented with creative activities (hotel programmes, four-season, cultural programmes, etc.) - Investments in smart infrastructure 	<i>proactive</i>	<ul style="list-style-type: none"> Compensating lack of snow with technical snowmaking → Direct and indirect allocation of costs to all stakeholders - direct charge of hospitalities - levies to tourist association - charge winter sportsperson through ticket sales (in the end hospitality takes over the costs = indirect charge of hospitalites) 	<i>reactive</i>	<ul style="list-style-type: none"> Cost savings → reduce offer (fewer slopes, cable cars, less snowmaking, less maintenance) → reduce investments (snowmaking technology, etc.) → reduce prices
Hospitalities	Primary stakeholder	<i>reactive</i>	Cooperation (DMO)	<i>reactive</i>	Individual programmes (soft cooperation)	<i>reactive</i>	Reduce prices to attract tourists and make special offers (e.g. christmas special)
Tourism-related businesses	Secondary stakeholder	<i>reactive</i>	<ul style="list-style-type: none"> - Cooperation (DMO) - Input - More businesses enter market (cultural institutions, etc.) 	<i>reactive</i>	<ul style="list-style-type: none"> Costs, offer and prices increase → businesses become more flexible (e.g. ski instructor becomes a mountain trainer/ entertainer) 	<i>reactive</i>	<ul style="list-style-type: none"> Cost savings → decrease quality and reduce offer → prices decrease → cost inefficient businesses are driven out of the market
Tourist association	Secondary stakeholder	<i>reactive</i>	<ul style="list-style-type: none"> Coordination of cooperation (DMO) embody a platform → adding more target segments (culture lovers, eco-conscious persons, etc.) → catchment area from nearby (climate-neutral arrival) 	<i>reactive</i>	<ul style="list-style-type: none"> Embody platform for financial redistribution - marketing: winter sports - catchment area: attract winter sportspersons from regions where winter sports is not possible (anymore) e.g. Pyrenees, Sierra Nevada, Asian regions 	<i>reactive</i>	Offensive marketing without innovations and with diminishing capital
Winter sports enthusiasts	Secondary stakeholder	<i>reactive</i>	Winter holidaymaker practises winter sports, if conditions allow it	<i>reactive</i>	Winter sports enthusiasts, who attach great importance to winter sports, do not shy away from costs and efforts	<i>reactive</i>	<ul style="list-style-type: none"> - Local winter sports enthusiasts still practise winter sports (when snow conditions allow it) - No acquisition of new skiers (beginners)
Civil movement	Influencer	<i>proactive</i>	Pressure to promote climate-neutral investments	<i>reactive</i>	Winter sports with this waste of resources and investment behaviour is not considered ecological and therefore rejected		<ul style="list-style-type: none"> - Positive perception of summer tourism - Winter tourism is regarded as negative because of its unecological orientation
Politics	Influencer	<i>proactive</i>	<ul style="list-style-type: none"> - Creation of (legal) framework conditions for cooperation - Tax relief for investments in new winter sports activities - Create investment incentives (free investments allowances, reduced depreciation periods, better tax rate for reinvested undistributed profits) 	<i>reactive</i>	<ul style="list-style-type: none"> Counteracting unemployment with financial support for tourism businesses - subsidies - direct investments in cableways - granting of favourable loans 	<i>reactive</i>	<ul style="list-style-type: none"> Unemployment effect → programmes for the creation of alternative jobs in the Alps → establishment of businesses that are independent of tourism (e.g. subsidies for wine-growing)
Technology	Influencer	<i>proactive</i>	<ul style="list-style-type: none"> - New transport possibilities to the mountains - Basis for new sports 	<i>reactive</i>	<ul style="list-style-type: none"> - Further research and development in artificial snowmaking - Attempts to substitute snow as a basis for winter sports (e.g. grass skiing) 	<i>inactive</i>	<ul style="list-style-type: none"> - Technology focuses on other economic sectors, but not on winter tourism - Winter sports industry lacks the capital for innovations

Table 5: Summary of all three scenarios

5 Conclusion

The present thesis tries to find answers for the future of winter sports tourism in the Austrian Alpine region which is subject to substantive threats of climate change in the forthcoming decade(s). Winter sports tourism is particularly driven by skiing and thus, gravely reliant on snow. In light of the disruptor global warming, this raises the question of how global warming affects winter sports and what shape this industry will take in the future.

It was found that a rise in temperature causes a shift in the snow, forest and lawn lines. Moreover, the occurrence of extreme weather events increases alongside a more frequent appearance of heat days. Positive aspects of the described shifts include the attraction of additional tourists to the Alps. Rising temperatures, however, cause glacier melting, which results in the exposure of permafrost and thus increased fall processes. Research assumes an increase of the snow-reliability line by 150m per degree temperature rise. A classification of the ski areas based on their snow-reliability lines shows that currently only 87% of the Austrian ski areas are snow-reliable. This situation intensifies with increasing temperatures due to global warming and reaches an extent of only 21% of ski resorts being snow-reliable in the worst-case scenario of a warming of +4°C. In this case, € 118.5 million of additional costs would be incurred for pure snow production. This rise in temperature is also associated with a reduction in turnover of winter sports tourism of € 7.3 billion. Especially the regions whose only main pillar is winter sports tourism will feel the effects of climate change in the form of sharp declines in tourism revenues, overnight stays and arrivals.

The developed scenarios show that the future prospects for winter sports are menacing if stakeholders do not react in time. Organizations should base their strategic measures on the prevailing conditions of the region including the financial situation, the commitment of local stakeholders and the concerns of tourists. As a remedy, artificial snow is only of limited use, as it is ecologically questionable and economically a price driver (e.g. for lift tickets). In addition, the conditions for snowmaking will become more difficult due to the rise in temperatures. Stakeholders must therefore abandon traditional solutions and adopt new, more innovative approaches, like the exploitation of weather conditions instead of focusing on alternatives to snow. If the primary stakeholders manage to set the course at an early stage, they have a decisive influence on the shaping of the industry. Above all, large cooperation represent a positive outcome for winter sports. All future scenarios anticipate a concentration of competition within the

industry. This implies that those businesses which manage to maintain their position in the market can generate a solid return.

This work is subject to some limitations, which were considered reasonable due to the scope of the work and for reasons of simplification. Calculations in chapter 4.1.2 are based on the assumptions that all ski resorts are of the same size and that every third euro spent by domestic and foreign guests is due to winter sports. These two assumptions can be conceptualized and revised by future in-depth research. Furthermore, no artificial snow was included in the loss in turnover, which does not correspond to practice and offers the possibility for further research. Future research can also address the future scenarios by broadening the scope of stakeholders and presenting their actions in even greater detail.

To conclude, with regard to winter sports tourism, the stakeholders of this industry should not waste precious time waiting for winter sports tourism to develop itself, but rather see the disruptor of the industry as an opportunity to reinvent themselves and leave new traces. Since climate change is already here, there is no more time to spare. In line with Reinhold Messner's philosophy the winter sports industry should meet this challenge by breaking new ground and overcoming the limits of its own imagination. This requires an innovative spirit that can move mountains. Managers can be inspired by these future scenarios and take introductory steps towards a sustainable winter sports tourism.

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Appendices

Appendix I. Competition for the difference in altitude

Climate change will inevitably cause the snow-reliability line to shift upwards, leading to a concentration of the few snow-reliable ski resorts, as explained in chapter 4.1.2. High correlation between bed occupancy and altitude can be observed. This suggests that lower-located areas could suffer dramatic declines in demand, rendering profitable winter operations unviable. This expectation is also reflected in the investment behaviour of some companies (hotels, ski lift operators, etc.) which are increasingly steering their investments or shareholdings towards ski resorts in higher altitudes (Schröcksnadel, fg).

Moreover, the development of higher locations for skiing purposes represents a strategy that is currently being pursued very intensively by some winter sports regions. This includes the expansion of ski resorts as well as new developments and mergers of ski resorts. (Güthler, 2003, pp. 9–10) All these strategies aim to relocate ski operations to more suitable locations, such as northern hillsides and higher areas or glaciers, because these areas are considered to be more reliable for snow. (Abegg, 1996, pp. 162–164) However, many ski areas cannot even put this "flight to the top" into practice. Especially low-lying ski resorts have a clear disadvantage. (Müller, ae) Furthermore, this flight entails a high technical and financial cost that cannot be borne by every ski resorts. An additional financial expense is required for example due to permafrost at such high altitudes, for which the necessary constructional precautions must be taken, or to the fact that the characteristics of the terrain can massively hamper the maintenance of the pistes. Operators of ski pistes also bear the risk of business interruptions due to harsh weather conditions at high altitudes. (Schröcksnadel, fg)

Appendix II. Guest behaviour and expectations

Demand for skiing

The decline in snow-reliability has triggered a concentration of the tourism industry, especially in low-lying areas (Borkmann et al., 2017, p. 38). Classic ski demand has declined sharply and is stagnating (Borkmann et al., 2017, p. 39). A declining number of skiers can already be felt in high-altitude ski resorts such as Lech/ Zürs, where the share of non-skiers is at approximately 15%. (Fercher, eb) Nevertheless, in a Delphi study with 33 experts from academia and practice, skiing was still found to be the most important offer of winter sports until at least 2030 (Figure 10). Further, winter experiences in harmony with nature, such as winter hikes, are becoming increasingly popular. (AlpNet e.V., 2016)

One problem currently affecting the sport of skiing is the lack of national and international offspring. Austrian school ski courses, for example, have not been supported for a long time and have consequently declined. (Manhart, cc) In the classic countries of origin such as Germany, people do not learn to ski as much as they used to (Jochum, dd). A recent study shows that most German winter holidaymakers are non-skiers (Bausch & Unseld, 2018). Thus, the customer pool from the previous catchment area becomes smaller in sum. On the other hand, countries like China which are currently promoting skiing extremely due to the upcoming winter Olympics bear new potential in the form of estimated 100 million skiers (Jochum, dd).

For the Alps as a tourist area, these changes in the market mean that in its most important catchment area Germany (as outlined in chapter 4.2.3) the guest as such has altered. But a change in the demand structure of leisure activities does not necessarily imply losing Germany as a catchment area for winter sports. In this respect, the study by Bausch & Unseld (2018) provides an important point of reference. It was found that the main motive for German winter holidaymakers is not skiing, but rather escaping the grey winter with its humid, cold, short days, with little daylight and sunshine. Therefore, especially guests such as non-skiers expect a winter landscape and an environment that contributes to relaxation. (Bausch & Unseld, 2018) The problem of offspring regarding skiers in combination with the genuine motivation for a winter holiday leads to the conclusion that a ski resort affected by climate change should direct its investment activities towards year-round tourism as well as snow-independent offers instead of technical snow production.

Winter landscape

Due to the reasons presented in chapter 4.1, the landscape will most likely take the form of snowless valleys, with only the high peaks covered in snow. This evokes the question whether a perfect winter landscape is a stringent requirement for guests. A study by Bausch & Unseld (2018) indeed underlines the importance of the snow experience during a winter holiday. Research suggests that even if there is acceptance for snow-free valley bottoms, the winter guest expects the creation of real winter and snow adventure areas on the summits. (Bausch & Unseld, 2018) This finding can be confirmed by a growing number of older clientele who like the ambience of a winter sports resort and thus choose to travel to the winter sports destinations solely for winter hiking (Fercher, eb).

Changes in offers

The trend towards a change of consciousness in society firstly became apparent in 2015 and continues to this day. Passive recreation on the beach is no longer in demand, but healthy recreation in nature, which can also include an active component. (Borkmann et al., 2017, pp. 40–41) Experiencing nature, recharging one's batteries, enjoying a healthy climate, taking care of one's health and exercising have a substantial meaning for nature holidaymakers today (Heß, 2008).

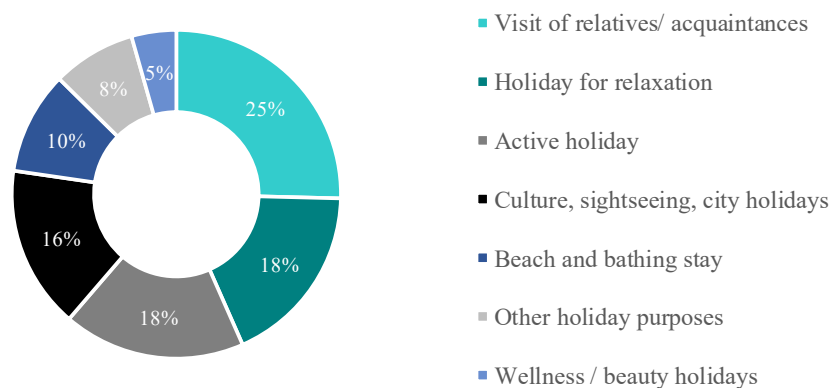


Figure 13: The most important travel motives 2018 (Statistik Austria, 2019d)

The topic of health is an integral part of Alpine tourism. With its popularity rising, "Health-Style" has been developed into an established lifestyle and is seized upon in various forms by all hotels. (Heß, 2008) Thus, all activities, as well as ambience design and nutrition serve the purpose of promoting health (Borkmann et al., 2017, pp. 40–41). Figure 13 underlines that active holidays have become significantly more popular and are now on a par with recreational holidays (Statistik Austria, 2019c).

Furthermore, it can be assumed that both wellness and health offers will continue to gain in importance and become comparable to more classical sports activities such as skiing and hiking (Müller, ad Muxel, bf, Fercher, ec).

Currently, there is a strong polarisation of products and services in the Alpine region, creating a divide between high-tech adventure worlds on one side and traditional villages without any technical infrastructure on the other side. Though both models perform very successfully as tourist attractions, investments in infrastructure clearly payoff when it comes to cost management. Lack of access to high-speed Internet railways and physical high-speed traffic routes is driving those affected out to the sidelines. (Wolfrath & Bauer, 2013)

Appendix III. Interview guideline

General

Please briefly describe and characterise your professional field and activities.

When/ Through which occurrence did the region/you realise that something had to be done?

Effects of climate change

Would you say that the winter sports industry is already affected by climate change and if so, where can you see the effects and how? *(some answers might be related to summer e.g. natural hazards (landslides) → stir back to winter)*

How are the stakeholders dealing with this problem? What measures are being taken?

Thought-provoking impulses:

- *Energy management (e.g. ecologically self-sufficient)*
- *traffic management*
- *Hotel projects (e.g. food self-sufficient)*

Guests

In the media there is more and more talk about change of booking behaviour of the guests. Are there already strategies in place to attract more guests to the ski resort, even if the weather conditions are still too far away or do not look good?

Snow-reliability

Do you think that the competitor landscape will concentrate on a few ski resorts because smaller or lower-located ski resorts will close down? What strategy do higher ski resort (> 1200m, e.g. Arlberg) pursue to ensure that its guests stay in the region in times of climate change?

Continuing this train of thought, imagine there would be four times as many skiers on the pistes as today.

- How is tourism/ hotel industry/ piste operators/ lift operators/ ski schools preparing for this?
- What effects could this have on the industry?

In your opinion, which strategies should lower-located ski resorts pursue? *Thought-provoking impulse:*

- *upgrading technologies for snow production or other technical measures*
- *alternatives to temporary snow scarcity*
- *cooperation*
- *financial support*
- *4 seasons tourism*

Individual stakeholder questions

Gebhard Jochum

- Where do you see your business in 15 years? how many hotels will cease to exist in their current form? *Impulse: conglomerate*

Hermann Fercher

- What strategy does the tourist association pursue to ensure that the ski resort continues to have a stable tourism industry in the future?
- Could you imagine changing the target groups of your guests? E.g. less sporty ambitious guests and more eco-guests?

Michael Manhart

- What strategies do you currently have in place to mitigate the effects of climate change?
- Could you imagine maximising the exploitation of the lifts? E.g. night skiing

- What percentage of the area on the Arlberg is artificially snowed? *Comparative values of other Austrian ski resorts*

Markus Schröcksnadel

- What strategies do you currently have in place to mitigate the effects of climate change?
- Do you pursue different strategies for the different ski resorts you are operating?
- Could you imagine maximising the exploitation of the lifts? *E.g. night skiing*

Christoph Müller

- What strategy could the ski school pursue in order to continue bringing its ski instructors to its customers? Do you have any concepts in mind? Where do you see yourself in 15 years?

Who do you think could lead the movement to promote and change the current structure of the winter tourism industry?

Appendix IV. Summaries of expert interviews

a. Interview partner 1: Christoph Müller (02.10.2019; 44:43 min)

Müller is deputy head of the ski school Zürs am Arlberg (Vorarlberg). He was chosen as an interview partner to explore the micro-perspective of a winter sports tourism business.

aa. Effects of climate change

Climate warming does not pose the main problem currently facing the winter sports industry. The lack of procreation (in terms of skiers) is causing problems for the ski resorts - especially for the ski school in the form of fewer guests and ski instructors. Temperature fluctuations, which are currently the subject of a great deal of media coverage, have already occurred in the past. For example, in the 1950s until the end of January skiing was only possible on the northern flanks of the regions (at least in Vorarlberg).

Nevertheless, smaller ski resorts in the foothills of the Alps are already suffering from global warming, but not ski resorts such as Arlberg in the High Alps.

In the High Alpine area warmer summers can certainly be observed, but temperatures fluctuate considerably from season to season. For example, in the summer of 2019, snow lay until June and northern pistes were covered with snow throughout the summer. Winter 2018/19 was very snowy with a total snow height of over 12m in Zürs. To illustrate the temperature fluctuations Müller remembers when he was still a child and could not ski in his regular skiing area due to lack of snow and had to switch to another higher-located skiing area to be able to ski.

If, however, there is a lack of snow, this is also noticeable in the higher ski areas. Then the pistes become more crowded with guests, who often take an extra hour drive to be able to ski.

ab. Guest behaviour

The booking behaviour of the guests is mainly influenced by their experiences. Two to three winters with little snow are devastating for the following winter season - regardless of the snow conditions in this winter. It takes a number of consecutive strong winters to bring the guests back to the skiing area, preventing them from going on a beach holiday. For the ski school it is very difficult to take action against this issue as the business is snowbound.

Glacier ski areas are flooded in the early winter. However, a prerequisite in this respect is that it snows in October. If it already snows in October, these ski resorts will benefit, but for ski resorts like the Arlberg this is still too early. These guests who ski in the pre-winter are typical for only booking the day before. However, all ski resorts (also higher situated ski resorts like Arlberg, Ischgl etc.) are struggling with the missing guests at the end of the season.

Additionally, as a ski school we observe that we have a strong generational problem. In former times we had many frequenters at the Arlberg, but due to the handover of hotel operators to the younger generation, many guests are no longer personally attached to a specific hotel. Accordingly, some guests break away. The ski school tries to compensate this lost turnover with guests from other villages.

In recent years the ski school business has changed from weekly booking to daily booking. While the weekly booking still exists, the daily booking has certainly increased. However, Zürs is also a "special" ski school, as it generates around 80% of its turnover through private ski lessons, i.e. not through group ski courses. These private ski courses are mainly sold on a weekly

basis. Group courses are mainly booked locally and not in advance, whereas this is often the case with private courses.

ac. Strategies for higher-located ski areas during weak winter seasons

There are no comprehensive strategies for global warming in place for higher-lying ski resorts such as the Arlberg ski resort in particular.

The snow-poor winters are in fact not as problematic - the snow-rich winters are worse for tourism. For example, last year in January the ski school performed poorer than in a snowy winter because the mountain pass was often closed and some pistes and lifts were not accessible due to excessive snow. Then there is also the high risk of avalanches, which often cause avalanche victims. Last year four "self-proclaimed" guides drove into a prohibited zone and died tragically. Afterwards the search for the victims could not be carried out due to the high avalanche danger. This led to very bad publicity. In this winter the ski school felt that many hotels had to accept cancellations. Hence, if there is too much snow or extreme weather conditions like last season, the booking situation is worse than if there is little snow.

ad. Strategies for lower-located ski areas

For instance, the ski area in the Brandnertal in Vorarlberg, which currently has a summer/winter tourism of 60/40, previously 30/70. As this shows, the trend for summer tourism is on the rise. This ski resort closes relatively early at the end of the season (compared to other ski resorts), as it has recognised that in late winter it is difficult to attract guests to the heights, while in early winter (November) skiers can hardly wait to kick off the season. Low-lying ski resorts should therefore invest in a variety of areas, primarily focusing on the summer season, in order to build up an additional mainstay or strengthen their position. This means to invest in facilities for wellness, tennis, golf, cycling parks, climbing parks, etc., depending on the local conditions.

ae. Mergers and associations of ski areas

Mergers of ski resorts should be viewed more critically, as there are geographical and topographical boundaries. However, a network of ski tickets is highly recommendable and expandable.

As far as the development of higher areas is concerned, however, one or two ski areas can certainly be developed, but the focus should rather be on the renewal of existing facilities, since

the ski areas in Austria are already at a very high elevation, such as the Öltal and Sülztal valleys. In addition, there should be enough land left for the game to retreat to.

af. Price acceptance

Price acceptance for ski holidays has already been driven to the top. Skiing has become a very expensive sport.

ag. Strategy of the ski school

The ski school business depends on several factors: geography, topography, infrastructure, local conditions. Emphasize should be placed on the flexibility of the ski school. For example, Müller himself has been snowshoeing with a guest for a week. Such "special activities" will be increasingly in demand and the ski school will have to respond with a corresponding range of services. Ski instructor qualification must be multisportive. This is slowly being put into practice, for example in Tyrol every ski instructor has to be a cross-country ski instructor.

ah. Leading player of the industry

The problem with Austrian ski resorts is that they are not typical resorts such as the Vail Resorts, which are centrally managed, but there are many individual players. A ski resort will therefore find it very difficult to undergo a transformation. However, if strong hotels join forces and cooperate with the ski lift operators, there might be a high potential to change the shape of the industry. Traditionally, the ski lifts were the pioneers and the hotel owners followed suit. This can be explained by the fact that many hoteliers are shareholders in the ski lifts. A shareholder may find it easier to try something new and invest (after all, it is money the shareholder has not seen yet).

b. Interview partner 2: Ludwig Muxel (02.10.2019; 29:19 min)

Muxel has held the office as mayor of Lech/ Zürs for 26 years and is therefore familiar with the issues of winter sports dependent businesses as well as the economic macro-perspective of a winter sports destination.

ba. Effects of climate change

There are regions that will get more precipitation, but more intensive in less time. The Arlberg region should be able to practise good winter sports in the coming decades. There will always be fluctuations. In the future, however, there may be more extreme fluctuations. This can lead to flooding etc. in summer.

bb. Strategies for snow shortage

The Arlberg has long since started to find alternatives to skiing. Many years ago the winter hiking trails were considerably extended. The expansion of the infrastructure for e.g. sports parks and mountain bike trails has been initiated. These activities can all be carried out with little or no snow.

bc. Target groups

An attempt is already being made to address different target groups by diversifying the offer (especially not snow-bound activities). The target group of sporty skiers is no longer the only one targeted. Guests want to spend their holidays in a place that has not destroyed nature, but where visitors can see that nature is respected. The guest would like to have authentic nature experiences.

bd. Competitor landscape

Lower situated ski resorts will soon have difficulties to remain profitable. But even the higher ski resorts will not all be able to hold their own. Ski resorts that know how to innovate and evolve in the hotel and gastronomy sector will have better prospects. The guest expects an increasingly high-quality gastronomy and hotel industry, in which holidays away from the snow is also possible.

be. Price acceptance

Even if some ski resorts shut down and therefore, due to supply and demand, ski pass prices rise, the guest will accept the price, provided the supply in the ski resorts is appropriate. The price will not determine whether or not a guest comes to the ski resort on holiday. Rather, the guest would like to be offered something worthy for the price. The quality factor is that even

with potentially fewer ski areas, the number of skiers on the pistes will not increase due to the limitation of 14,000 skiers (in the Lech/ Zürs area) permitted to be in the ski area at the same time. In addition, some villages, such as Lech, have a very strict development plan, which prevents the village and thus the number of beds to be expanded even further.

bf. Strategies of lower-situated ski areas

Exploitation of the local conditions. A good infrastructure is essential. In addition to the sports facilities, the wellness and health facilities should also be expanded.

bg. Strategies for ski resort Arlberg

Lech/Zürs is currently striving to expand not only summer tourism, but also spring and autumn. Especially this year, a hotelier in Lech is the first hotel in the area to try its hand at autumn business. Hence, four-season-tourismus will be expanded. In summer, the cultural programme is being intensified. The area also benefits from the fact that young people have rediscovered hiking and now regard it as fashionable.

bh. Development of higher areas

Lech/Zürs does not want the ski area to be extended any further. In the future investments will be made in quality, but not in size.

bi. Climate neutrality

Traffic management

The parcel Oberlech (1,300-1,500 guest beds) is entirely traffic-free thanks to the underground parking system. Guests use the free local, ski and hiking bus, which operates throughout Lech/ Zürs. Upon arrival, guests can either use the underground car park, where every hotel has direct access, or leave their car in the lower-located Lech and be transported to Oberlech by mountain railway (incl. luggage delivery). About 70% of the Oberlech guests who arrive by car take advantage of these environmental protection measures by leaving their car in Lech and taking the mountain railway to their accommodation. Additionally, there is a parking guidance system, which announces the capacity utilisation of the public parking lots 60km before Lech. For electrified vehicles there is already an electric garage with 26 charging stations that run on green

electricity. Further projects for public transport are planned (projects concerning electoral technologies and hydrogen).

Another prime example of the successful implementation of traffic management is the air cushion lift in Serfaus, which transports guests from the car park on the outskirts of the village to the valley station of the cable car.

Energy management

Lech/ Zürs owns four biomass heating plants that replace 8.5 million litres of heating oil per year. The coverage is 80%, i.e. 80% of the oil heating was replaced with these heating stations.

bj. Cooperation

Cooperation are generally very important and goal-oriented. However, the small structure of this sector hinders the formation of cooperation, which is why hardly any currently exist.

bk. Lech/ Zürs in 15 years from now

In terms of technology, Lech/ Zürs is one of the market leaders in the winter sports industry. Lech/ Zürs will continue to be a lifestyle resort, which is visited by families but above all also for the upper class.

bl. Leading player of the industry

There are still great challenges ahead in terms of the development of mobility and ecology. Ski lifts must create new offers. The destination leader, i.e. tourism and the hotel industry, will be the driving force.

c. Interview partner 3: Michael Manhart (03.10.2019; 83:18 min)

Manhart is a board member of Rüfikopf Seilbahn AG and managing director of Bergbahn Lech-Oberlech and Rud-Alpe Gastronomie GmbH. He was also managing director of Stubner Fremdenverkehrsgesellschaft m.b.H. and Auenfeld-Jet Seilbahn Ges.m.b.H. & Co. KG, and second managing director of the ski lifts Schröcken. Manhart has performed important pioneering work, especially in the field of environment and snowmaking as well as avalanche protection. He is the manager of numerous projects concerning high-altitude greening and

renaturation as well as the revitalisation of protection forests. Since the 1970s he has been involved in snowmaking on the Arlberg and installed the first snow cannon in this area.

ca. Effects of climate change

Due to the high location of Lech/ Zürs, an optimistic position towards the future of winter sports can be presumed. Lech/ Zürs will remain a winter and summer tourist destination for a long time to come. It is the hot summers that drive the southerners into the mountains. But it is precisely because of these warm summers that the Austrian glaciers are melting. For example the Pasterze (biggest glacier of Austria below the Großglockner) retreats constantly. But the name Pasterze means cow meadow in German, which lets us assume that these heights were not always completely covered in snow. In the area of the receding glacier tongue, tree trunks (Swiss stone pine trunks) appear today. This means that either the Neanderthals were already cruising through the Alps in thick Porsches, or more likely that global warming can be considered "normal" in Earth history. If things continue like this, the European glaciers will soon be ice-free.

cb. Natural hazards

When it gets warmer, the vegetation line rises. How dramatic this is, however, remains to be seen. For example, this can be seen in the dying forests in the early 80s: at that time, environmental experts warned of an environmental disaster of unprecedented proportions in which it was predicted that there would be no more forests in 20 years. After a heavy downpour and thanks to wind sowing, the forest has turned green again. Especially with the forest the influence of man is very noticeable. For example, after cutting down the jungle, a spruce monoculture was planted, which means that the forest is not as robust as a mixed forest, but thanks to the generous cutting area, we have piste area at our disposal. As a matter of fact, the forest stock is increasing, but the forest struggles with some problems, such as windthrow. Since spruce is a shallow-root plant and not a deep-root plant as is the case in mixed forests, severe storms often cause major damage to forests. A mixed forest would also be much less susceptible to such problems as the bark beetle (which recently paralyzed the entire timber industry). Manhart once started the experiment of forest fertilization, where he fertilized the forest with a helicopter, whereupon it revived and started fermenting again. There are two sides to deadwood from windthrow. On the one hand it is biomass, which rots and is a base for seedlings, on the other hand

it is also an incubator for the bark beetle. So in order to protect the forest one would have to burn all dead wood - but this is again a big contradiction to climate protection.

The bottom line is that natural disasters have not increased, but that this is merely hysteria on the part of the media. This is also shown by studies of seafarers' logbooks, which already record a large number of storms before the industrial revolution. Factors such as the expansion of settlement activities (people building houses in the rearmost corners of an avalanche valley into an avalanche track) cause an avalanche to become a media blast and be associated with climate change. Even in the disastrous summer of 2005, which is repeatedly mentioned, massive eruptions and mudslides occurred in the villages, but in the ski area everything was calm. This shows once again that the man-made constructions caused the damage.

Alternatives to better capacity utilisation, such as night skiing, are countered by objections, e.g. from the piste operators, which is why this was not implemented at the Arlberg.

cc. Target groups

A problem that currently affects winter sports even more than climate change is the lack of offspring. For a long time, school ski courses were not promoted and have declined (legal reasons for teachers). The cable car industry could provide more support for school ski courses.

cd. Strategies due to climate change

Lower ski areas should be artificially snowed, while hoping that temperatures do not increase any further. A programme that is largely snow-independent should be created. The promotion of the summer resort, recreation programme and cultural programme is advisable. There are some efforts to find some niches and to fill them. Important issues are the strengthening of summer and year-round tourism.

ce. Climate neutrality

For a long time, attempts have been made to ensure sustainable development on the Arlberg. Spatial planning and energy planning are essential components. When it comes to land use, great attention is also paid to biodiversity. The energy management of the ski lifts is presentable. Ski lifts rely on bioenergy (geothermal energy, solar heat, solar power). The cable car facilities are perfectly suited for solar panels/ photovoltaics, due to the increased radiation in the mountains as in the valley.

cf. Guest behaviour

Lengths of stay have decreased dramatically. Lech/ Zürs is very concerned about its frequenters, as they are more inclined to book longer holidays. As a tourist resort, however, one has no influence on the holiday behaviour. However, efforts are currently being made to find new hotel concepts for hotels in order to address other target groups.

In addition, a generational problem - especially with regard to hotel handovers - can be observed.

cg. Industry outlook

In the long term, ski resorts from 1,000m upwards in combination with snowmaking can be regarded as snow-reliable. Smaller ski resorts, with only a few lifts, which are operated by the village itself, will certainly have problems. However, lower-lying ski resorts will generally be unprofitable in the long run and will be forced to close down or practise winter sports without snow (e.g. grass skiing, plastic pistes, toboggan runs). However, even if there were few ski resorts, there would be no more skiers on the pistes. This safety on the pistes is ensured by the piste operators, who have already set a limit of 14,000 skiers in Lech/ Zürs who are allowed to be in the ski area at the same time. (Limit only applies 4-5 times in the whole winter).

ch. Development

Expansion of the ski area is inconceivable due to geographical and political reasons. The renaturation of the lower situated areas does not matter for the balance of nature. The use of nature by ski resorts is not dramatic.

ci. Technical snowmaking and vegetation

Today, the main focus is on full automation in order to make optimum use of the conditions. Technical snowmaking is a science in itself, as it requires certain weather conditions (humidity, temperature, etc.).

In the 80s skiing was in disrepute. It was said to destroy the mountains, the Alpine pastures and the forest in favour of new pistes. Especially the snow cannons, which extend the season, were criticised. Snowmaking would hinder the exchange of gas, and the vegetation would suffer. This was incorrect, however, as can be seen on the piste "Schlegelkopfhang" (long since snow-

covered piste in Austria, since 1973), where a diverse vegetation exists. A comprehensive documentation of the University of Natural Resources and Life Sciences Vienna is also available which confirms with a detailed vegetation survey that the vegetation is not damaged despite levelling and snowmaking. This is how such a good vegetation was able to thrive: lawn sods were cut out and laid on the side, the terrain was changed, then lawn sods were laid up again. It is also possible to renature slopes at over 2,000m. This is achieved with manure from highland cattle and dairy cows. Example: at 2,300m a mountain station is artificially snowed and successfully renatured despite earth movements (which is typical for this area).

cj. Leading player of the industry

Changes do not happen lightly in this industry. The construction of the Auenfeldjet (connecting two ski resorts) was discussed for 40 years until it was finally implemented. The main drivers need to be the big hotels and the tourism association. Then the ski lifts will go along, but will not initiate any change. In the past, enquiries from ski lifts were often obstructed.

d. Interview partner 4: Gebhard Jochum (03.10.2019; 44:11 min)

Jochum is a hotelier of a 5-star hotel (Sporthotel Lorünser) in Zürs. He also holds other positions in the winter sports industry such as a seat on the supervisory board of Rüfikopf-Seilbahn AG and Skizürs AG and is a member of the management board of Bergbahnen Stuben. In addition, he was the head of the Zürs Tourism Association for many years and was a member of the advisory board of Lech/ Zürs Tourism, as well as of the municipal council and the construction committee of the municipality of Lech. Jochum's perspectives are therefore highly relevant for this master's thesis due to his expertise in a winter sports resort as well as in the hospitality sector.

da. Effects of climate change

At the moment, climate change has no influence on snow conditions. But this is certainly somewhat concealed by the snowmaking facilities. However, the snow systems cannot be attributed to changes in the conditions of climate change, but to the demand for reliability to start the season on time or before Christmas, as well as to quality assurance. By now, snowmaking starts in November or even earlier to open the season in time at the end of November. When Jochum was still a child, in December the skiers rumbled over the stony pistes. Thus 40 years ago there

was not always snow in December. In the short term, there is no influence of climate change to be seen here. In the long run, however, it can be safely assumed that the winters will become warmer, which in turn will lead to less snowfall. But no one knows. One should not allow oneself to be lulled into safety by future scenarios regarding climate change.

db. Strategies due to climate change

Despite the many discussions about climate change, hardly any exit strategies can be seen on the part of companies. Extreme offensive strategies can be observed among ski lifts and hoteliers.

Summer tourism is very much in the focus, as it promises many opportunities, through summer resorts, climate tourists, etc.

There are ideas of health hotels, self-catering hotels etc., but no clear concepts yet. Such concepts are difficult to reconcile with winter sports. Either one runs a ski hotel or a medical health hotel. The entire decline in skiers will not be compensated with these alternatives. However, all these concepts and strategies are very location-dependent. Zürs, at 1,700m in the middle of the Arlberg region, has the greatest chances of success as a pure ski resort. Accordingly, hotels should be pure ski hotels. If one is situated lower, as for example Kitzbühel or St. Anton, one should diversify his offer more broadly.

dc. Guest behaviour

In Jochum's hotel the majority are still regular guests. 80% of his guests already book provisionally on departure for the coming season and then confirm this booking only again in summer. In this case, the short-term guests make up very little.

At present there is still no strategy for the reduction of the regular guests. The Lech/ Zürs region has performed very well due to the many frequenters, but this is precisely why deficits have arisen, for example in marketing. Since the booking behaviour of the guests is changing, there is a great backlog demand in terms of sales on long-distance markets, with partners such as travel agencies.

dd. Target groups

In skiing, there are immense concerns for the offspring. Especially from the classic countries of origin like Germany, people do not learn to ski as much as they used to. On the other hand, there are countries like China, which is now extremely promoting skiing due to the upcoming Olympics. The potential in China is said to be up to 100 million skiers. China is massively expanding its ski resorts and is acquiring the necessary know-how from Europe. Some climate tourists can certainly be attracted to the Alps, but one has to remain realistic. Nowadays it is very easy for these people to fly on holiday somewhere else.

de. Development of skiing

The problem is that on the one hand ski passes have become more expensive, but equipment is also becoming more expensive. This is not advantageous for skiing, as a national sport.

df. Position of Hotel Lorünser in 15 years

In 15 years, the Hotel Lorünser will be positioned on the market just like it is now. The Lorünser is one of the strongest ski-focused hotels on the Arlberg, with a frequented guest. This is also reflected in the daily number of private ski instructors who are not comparable to other hotels. For example, the wellness area should never become a booking motive for the Lorünser. Wellness is simply regarded as a must-have.

dg. Destination management organization

There are already considerations for cooperation (e.g. kitchens). In this respect, there are also advanced models such as a public limited company, in which the hoteliers can incorporate their hotels and thus participate in the overall profit, but are centrally managed by a management. If there is one place that is predestined for such cooperation, it is Zürs, due to its size. This would open up completely new possibilities, ranging from marketing and orientation to the exploitation of synergies. Costs for distribution and booking systems would then be lower. This type of cooperation is known as Destination Management Organizations and is very common in the USA, for example. Currently, every hotelier does its own marketing. This does not convey a homogeneous picture of a destination. Since the family hotel structure is currently generally declining due to the generation change, such concepts are quite conceivable.

dh. Leading player of the industry

So far, it has always been individuals who have actively set trends. The tourism association generally keeps up, but does not lead. The ski lifts cannot realistically provide much except a good offer. Until now, ski lifts have always been very innovative and willing to invest. However, a corporate body will hardly bring about a change, which is why one or more companies would have to initiate the transformation.

e. Interview partner 5: Hermann Fercher (03.10.2019; 37:01)

Hermann Fercher is the managing director of Lech/ Zürs Tourismus and is therefore in charge of the future strategic orientation of winter sports destinations.

ea. Effects of climate change

The Tourism Association Lech/ Zürs has had scenarios drawn up based on current climate research results. The opinion is that by 2050 warming will probably not exceed 1°C from 1,500m above sea level. The current business model will therefore not be endangered until 2050. However, extreme volatilities in the range (+/- 20°C) are also predicted. The challenge is therefore to be seen as a holiday destination to which one can travel regardless of the weather conditions.

At the moment, climate change is noticeable in more frequent warm wind (Föhn) inflows (also statistically proven). Apart from that, neither the average amount of snow nor the average temperature changes are noticeable. Due to discussions about climate change, many guests tend to go to higher ski resorts to be on the safe side.

eb. Guest behaviour

Anything above 1,500m is considered very reputable. In Central Europe, the number of skiers is declining. This can already be felt in Lech/ Zürs. A growing number of older clientele can also be observed, who like the ambience of a winter sports resort and therefore come to winter hiking. The proportion of non-skiers is 15%.

ec. Strategies for higher-located ski areas

Currently, all companies are adhering to their business model. The maximum variant of a strategy is to think about what to do at the start of winter if there is no snow (alternative programs).

The problem with lack of snow in December is that the Christmas holidays amount to about 20,000 overnight stays. So if there are many cancellations during the Christmas holidays, the hotels can hardly make up for the losses during the season.

Hotels such as health hotels, ecological hotels, wellness hotels etc. play an important role in the summer and autumn strategy.

ed. Target groups

Demand in Lech will not continue to rise even with a declining number of ski resorts. In Lech/ Zürs, the high-priced image will continue to be cultivated, thus addressing the upper class as a target group. This target group will not be deviated from in the future.

ee. Mergers and associations of ski areas

The size of the ski area is not a unique selling point. The variety of ski runs (length and steepness), piste maintenance and snow cover are decisive. In addition, the ski area must create a social atmosphere where entertainment is guaranteed and a sense of belonging is created. A ski resort can also stand out from other ski resorts in terms of accessibility and travel time. Due to the snow-reliability, there will certainly be fewer ski resorts and more people will ski on the pistes. The response to this could be broad runs and limited ski passes (both available in Lech). Sooner or later other ski resorts will have to think about a limitation. In Lech/ Zürs, the ski area will not be expanded any further. This is a question of ethos. One must also admit that landscape consumption is not unlimited. Ski area mergers from Ischgl to St. Anton represent a gigantism that must not be implemented because it represents too great an encroachment on natural spaces. Similarly, night skiing is seen as an environmental sin due to light pollution.

ef. Strategies for lower-situated ski areas

Effective strategies only happen when climate change is on the doorstep and there truly is no more snowfall. Only then will those responsible take action. Snow depots and such inventions are merely cornerstones for today and not for the future.

eg. Leading player of the industry

There will be no lead player, but rather an interplay of forces. The use of the mountains will play an important role, which is why the ski lifts and piste operators will need to initially open up for new ideas.

f. Interview partner 6: Markus Schröcksnadel (07.10.2019; 39:46 min)

Schröcksnadel (CEO) and his company operate mountain railway companies such as ski pistes, gastronomy, hotels and ski rentals. The company also supplies IT systems for tourism in general. These include reporting systems, card systems, booking machines and marketing systems for ski resorts, supplying information systems and acquiring advertising sponsors for ski resorts. Schröcksnadel was chosen as an interview partner because he has insight into strategies and operations of several ski resorts and therefore also a foresight and generic view of the industry.

Schröcksnadel is in constant contact with the climatologists at ZAMG regarding the issue how climate change will affect the company as a provider of winter sports in the individual forecast scenarios. The conclusion is that, according to ZAMG studies, nothing will change in the Alpine region over the next 30-50 years.

fa. Effects of climate change

The glaciers clearly show that it has been getting warmer since 1850. Nevertheless, around 1880 there were pilgrimages to the glaciers in Tyrol to pray that the glaciers would not come down any further.

However, there are currently no noticeable effects on winter sports. There is a positive effect on mountaineering in summer, as there are more sunny days and more people visiting the Alps.

Austrian ski resorts can take advantage of the climate change discussion as there is nothing more sustainable than Alpine tourism. 90-95% of all guests coming to the Austrian Alps come from a catchment area of 500km. This means that all of them are self-drive guests. Thus possibilities are given for journeys with public means of transport. This is rather difficult for long-distance tourism. Austria's ski resorts are therefore the holiday destinations that are most compatible with the climate objectives. Also, it has to be mentioned that there is a lot of false reporting about climate change.

fb. Guest behaviour

Hiking has become much more fashionable. 40 years ago, hiking with parents was something dull. Through the Red Bull generation (extreme mountaineers), hiking is considered trendy today. The closeness to nature has become a lifestyle.

There are already strategies for the changed booking behaviour of guests, such as making the guest a member (e.g. Skiclub), push messages on the mobile phone and e-mails to motivate the guest. The strategy is basically making direct contact with guests through digitalization.

fc. Target groups

Austria lies in the middle of the richest countries in the world. The ski resorts should concentrate on these countries with regard to the catchment area of the guests and not pursue strategies to acquire guests from Asia who have to travel by air. If one replaced 30% of the German guests with e.g. Chinese, this alone would lead to logistic complications.

fd. Strategies for snow-reliability

The Kitzbühel ski area is already opening the ski season in October because it stores the snow over the summer. Back then, no one ever skied in October. Thus this is only one way for the ski resort to show what is possible with new technologies and that climate change can be counteracted. But snowmaking is not the solution of the problem and further, is a very costly undertaking. The production 1 m³ of artificial snow costs approximately € 2-4. Otherwise, concrete strategies can only be developed if changes are really dramatic.

fe. Strategies for higher-located ski areas

Tourism follows natural conditions. There are places that are traditional ski resorts, such as Pitztal or Züers. Almost only skiers go there. These places do not have to diversify their offer, because if you do not ski there, you are the wrong guest for this area.

ff. Price development

If there are ever fewer ski resorts, skiing will surely become even more expensive than it already is. Skiing has become more expensive over the years. The ski resorts are already registering

more added value with the same number of guests as a few years ago. Ski sport is becoming increasingly elitist.

If some ski resorts in the Alps have to shut down due to climate change, the skier who still wishes to ski will accept the high price. In the Alps there are only 2-3 ski resorts that are open in summer. These include Saas-Fee and Zermatt. In summer, Saas-Fee is as expensive as Zermatt, although Zermatt is three times as big in winter. In summer, Saas-Fee is working at full capacity. In summer a day ticket in Saas-Fee costs CHF 75 and only includes 5 cable cars. Nevertheless, this price is paid without hesitation because there are simply no alternatives.

fg. Strategy of the company in the face of climate change

High correlation between bed occupancy and altitude can be observed. Thus, companies seek to acquire a stake in many high-altitude ski resorts. The problem is, however, that this migration to higher altitudes entails high technical and financial costs that cannot be borne by all ski resorts. Financial additional expenditure, because e.g. in such high locations permafrost is to be expected, for which the necessary constructional precautions must be taken, or the terrain characteristics can make the maintenance of the pistes massively more difficult/ expensive. As a piste operator, there is also the risk of interrupting operations due to harsh weather conditions at high altitudes.

So far, no exit strategies can be observed, not even for the lower-located ski areas.

fh. Structural changes in the industry

A group formation of the individual skiing areas is to be observed abroad. An example is the American Vail Resorts or Scandinavian SkiStar. These resorts verticalize their supply chain in such a way that a ski resort owns, for example, hotels, a ski school, a ski rental and land. However, this approach is very difficult in the Alpine region due to the small structure.

As a company we are currently building a hotel in Hinterstoder for the reason that nobody else can afford it.

fi. Operating days

For example, many areas wanted to shut down in 1989 due to the fact that there were very few snow days and consequently the average operating days were at an all-time low of less than 40. These interruptions no longer exist thanks to technical snowmaking.

Appendix V. Contrasting juxtaposition of interview insights

	Effects of climate change	Behaviour of guests	(New) target groups	Strategie of higher situated ski resorts	Strategies of lower located ski areas	Ski are associations/ development of higher areas	Price
Müller	- no current influence on winter sports - warmer summers	- depend on experience (former seasons) - decrease in length of stay (from weekly to daily booking) - ski resorts are flooded in early winter - decrease in regular guests due to generational change of hotel operators		- focus on core competence (skiing) - open ski season early	- diversification of offer for summer activities/ facilities - open and close ski season early - exploitation local conditions	- geographic/ topographic limitations - focus on renewal of existing facilities - respect nature	- price acceptance is already at its limit
Muxel	- decreasing snow reliability at the beginning of winter		-attraction of various target groups (incl. non-skiers))	- development of snow-independent activities in winter - enhancement of summer resort tourism	- exploitation of local conditions - development of snow-independent activities in winter - enhancement of summer resort tourism	- no extension of ski areas - respect nature	- costs of skiing are balanced due to supply and demand - thus, costs are not the decisive factor
Manhart	- no current influence on winter sports - "climate refugees" in summer	- decrease in length of stay (from weekly to daily booking) - decrease in regular guests due to generational change of hotel operators		- technical snow making - focus on core competence (skiing)	- technical snow making - development of snow-independent activities in winter - enhancement of summer resort tourism - year-round tourism	- geographically/ topographically not possible (already high up) - no objections due to utilization of nature	
Jochum	- no current influence on snow conditions	- decrease in regular guests due to generational change of hotel operators	- target guest should vary due to local conditions (e.g. Zürs = skier)	focus on core competence (skiing)	- diversification of offer for summer activities/ facilities - enhancement of summer resort tourism		- increase in costs of skiing - costs of skiing are balanced due to supply and demand - thus, costs are not the decisive factor - only upper class will be able to afford it
Fercher	- no current influence on winter sports	- more non-skiing activities due to older clientele (lack of offspring)	-focus on upper class (no alteration of target group)	- new hotel concepts for summer/ autumn tourism		- no extension of ski areas - respect nature	- willingness to pay of upper class
Schröcksnadel	- melting of glaciers - no current influence on winter sports - more sunny days in summer	- hiking is regarded as hip - alteration in booking behaviour	-focus on neighbouring countries as catchment area	- focus on core competence (skiing) - open ski season early		- geographically/ topographically not possible (already high up)	- costs of skiing are balanced due to supply and demand - thus, costs are not the decisive factor and prices will be accepted

Table 6: Consolidation of interview responses

Appendix VI. Calculations and data

Altitude of natural snow-reliability line	Federal states	Ski areas	Snow-reliable under present conditions	%	+1° C	%	+2° C	%	+4° C	%
1,050 m	Salzburg	39	35	90%	29	74%	24	62%	9	23%
	Styria	37	34	92%	26	70%	17	46%	5	14%
	Lower Austria	13	9	69%	2	15%	1	8%	0	0%
	Upper Austria	11	7	64%	4	36%	2	18%	0	0%
1,200 m	Tyrol	79	75	95%	61	77%	45	57%	23	29%
	Vorarlberg	25	19	76%	16	64%	12	48%	3	12%
	Carinthia	24	20	83%	15	63%	14	58%	7	29%
> 1,500 m	n.a.									
Total		228	199	87%	153	67%	115	50%	47	21%
Average of all federal states		33	28	87%	22	67%	16	50%	7	21%

Table 7: Snow-reliability of ski areas in the Austrian Alps (following Agrawala & OECD, 2007)

Altitude of natural snow-reliability line	Federal states	Ski areas	Snow-unreliable under present conditions	% snow-unreliable	+1° C	% snow-unreliable	+2° C	% snow-unreliable	+4° C	% snow-unreliable
1,050 m	Salzburg	39	4	10%	10	26%	15	38%	30	77%
	Styria	37	3	8%	11	30%	20	54%	32	86%
	Lower Austria	13	4	31%	11	85%	12	92%	13	100%
	Upper Austria	11	4	36%	7	64%	9	82%	11	100%
1,200 m	Tyrol	79	4	5%	18	23%	34	43%	56	71%
	Vorarlberg	25	6	24%	9	36%	13	52%	22	88%
	Carinthia	24	4	17%	9	38%	10	42%	17	71%
> 1,500 m	n.a.									
Total		228	29	13%	75	33%	113	50%	181	79%
Average of all federal states		33	4	87%	11	67%	16	50%	26	21%

Table 8: Snow-unreliable ski areas in the Austrian Alps (following Agrawala & OECD, 2007)

Federal states	Present conditions	+1° C	%	+2° C	%	+4° C	%
Salzburg	35	29	83%	24	69%	9	26%
Styria	34	26	76%	17	50%	5	15%
Lower Austria	9	2	22%	1	11%	0	0%
Upper Austria	7	4	57%	2	29%	0	0%
Tyrol	75	61	81%	45	60%	23	31%
Vorarlberg	19	16	84%	12	63%	3	16%
Carinthia	20	15	75%	14	70%	7	35%
Total	199	153	77%	115	58%	47	24%

Table 9: Comparison of snow-reliable of ski areas in temperature scenarios to snow-reliable ski areas under present conditions (following Agrawala & OECD, 2007)

Assumptions:					
Snow cover	in m				
	0.3				
Costs of producing 1m ³ snow	in m ³	average			
	€ 2-4 →	€ 3			
Further Information:					
Pistes in Austria	in m ²				
	237,000,000				
	Average of snow-unreliable area (in %)	Average of snow-unreliable area (in m ²)	Technically snowable area (70%)	Volume of snow production (in m ³)	Technical snowmaking costs (in € MM)
Present	13%	30,144,737	21,101,316	6,330,395	€ 19.0
+1° C	33%	77,960,526	54,572,368	16,371,711	€ 49.1
+2° C	50%	117,460,526	82,222,368	24,666,711	€ 74.0
+4° C	79%	188,144,737	131,701,316	39,510,395	€ 118.5

Sources:	Pistes in Austria	(Wirtschaftskammer Österreich, 2018)
	Snow cover	(OECD, 2006)
	Costs for snowmaking	(Schröcksnadel, fd)

Table 10: Technical snowmaking costs by temperature scenarios (assumptions based on OECD, 2006, Wirtschaftskammer Österreich, 2018a, Schröcksnadel, fd)¹⁶

¹⁶ Costs of producing 1m³ snow include costs for energy, water and manpower.

Calculation of effects of temperature scenarios on the turnover of winter sports tourism						
Nominal tourism income from domestic and foreign guests						
Assumption:		Every third euro spent by domestic and foreign tourists in Austria can be attributed to winter sports (Arbesser et al., 2008).				
<i>€ in Bn</i>						
	Tourism turnover (winter season)	Tourism turnover (summer season)	Total	Every third euro is due to winter sports		
2008	€ 11.7	€ 10.1	€ 21.8	€	7.3	
2009	€ 11.5	€ 9.5	€ 21.0	€	7.0	
2010	€ 11.4	€ 9.7	€ 21.1	€	7.0	
2011	€ 11.4	€ 10.3	€ 21.7	€	7.2	
2012	€ 11.5	€ 10.3	€ 21.8	€	7.3	
2013	€ 12.0	€ 10.7	€ 22.7	€	7.6	
2014	€ 12.0	€ 11.0	€ 23.0	€	7.7	
2015	€ 12.7	€ 11.7	€ 24.4	€	8.1	
2016	€ 13.1	€ 12.2	€ 25.3	€	8.4	
2017	€ 13.3	€ 12.7	€ 26.0	€	8.7	
2018	€ 14.1	€ 13.3	€ 27.4	€	9.1	

	Numbers of ski areas	Revenues (€ in Bn)	Loss of turnover (€ in Bn)	Changes
Present	228	€ 9.1		percentage 4%
+1° C	153	€ 6.1	(3.0)	
+2° C	115	€ 4.6	(4.5)	€ (1.5)
+4° C	47	€ 1.9	(7.3)	€ (2.7)

Table 11: Temperature scenarios applied on the turnover of winter sports tourism (assumptions based on Statista, 2019)

Investment areas of the cableways companies			
<i>€ in MM</i>			
FY	Safety, comfort & quality of the systems	Snowmaking (new construction, modernization)	Miscellaneous (slopes, access systems, snow groomers, car parks, restaurants, etc.)
2007	206	203	123
2008	264	163	122
2009	287	152	123
2010	293	102	98
2011	298	82	123
2012	263	131	98
2013	252	89	136
2014	257	132	151
2015	232	154	186
2016	353	94	147
2017	212	119	206
2018	261	114	225
Total Investments			6,451

Table 12: Investment areas of the cableways companies by FY (Wirtschaftskammer Österreich, 2019c)

Countries of origin by overnight stays of winter season 2018/19										
<i>in MM</i>										
Countries of origin	Winter season 2018/19									
Germany	26.9	<table border="1"> <tr><td>Foreign guests</td><td>56.4</td></tr> <tr><td></td><td>77%</td></tr> <tr><td>German guests (of foreign)</td><td>48%</td></tr> <tr><td>Austrian guests</td><td>23%</td></tr> </table>	Foreign guests	56.4		77%	German guests (of foreign)	48%	Austrian guests	23%
Foreign guests	56.4									
	77%									
German guests (of foreign)	48%									
Austrian guests	23%									
Austria	16.5									
Netherlands	6.3									
United Kingdom	2.4									
Switzerland & Liechtenstein	2.3									
Czech Republic	1.9									
Belgium	1.7									
Poland	1.3									
Hungary	1.2									
Italy	1.2									
Denmark	1.1									
France and Monaco	0.8									
Other countries	9.4									

Table 13: Countries of origin by winter season 2018/19 (STATcube, 2019a)

Year	Winter season (in MM)	Summer season (in MM)
1974	27.8	71.2
1975	31.1	73.7
1976	32.9	72.1
1977	34.2	70.6
1978	36.8	71.0
1979	37.4	74.8
1980	39.8	78.2
1981	43.1	78.2
1982	44.4	74.9
1983	43.4	72.2
1984	44.4	69.5
1985	45.3	67.7
1986	46.1	67.2
1987	47.0	66.8
1988	48.1	68.2
1989	50.5	72.1
1990	48.8	74.0
1991	51.4	78.1
1992	53.1	77.4
1993	54.1	73.6
1994	52.9	69.6
1995	51.4	65.6
1996	50.5	61.9
1997	48.8	60.0
1998	49.5	61.3
1999	52.1	61.2
2000	53.4	59.6
2001	55.3	59.2
2002	56.3	60.2
2003	56.8	61.1
2004	58.1	59.8
2005	59.2	59.6
2006	59.9	59.0
2007	59.4	60.9
2008	63.3	62.4
2009	62.9	61.7
2010	62.7	62.5
2011	62.1	64.0
2012	64.3	65.7
2013	65.6	66.5
2014	64.5	67.2
2015	65.9	69.4
2016	68.5	73.0
2017	68.6	75.0
2018	71.8	76.7
2019	72.9	

Table 14: Overnight statistics by season since 1973/74–2018/19 (STATcube, 2019b)¹⁷

¹⁷ Year 1974 refers to the 1973/74 winter season, and the same applies to all years.

Year	Overnight stays winter seasons	Arrivals winter seasons	Length of stay
1974	27,773,591	4,624,734	6.0
1975	31,118,727	5,034,613	6.2
1976	32,895,477	5,283,032	6.2
1977	34,231,719	5,526,980	6.2
1978	36,836,979	5,957,438	6.2
1979	37,447,549	6,124,758	6.1
1980	39,797,667	6,494,904	6.1
1981	43,102,204	6,958,364	6.2
1982	44,418,416	7,256,924	6.1
1983	43,422,813	7,207,318	6.0
1984	44,430,557	7,681,562	5.8
1985	45,309,431	7,759,877	5.8
1986	46,125,912	8,026,830	5.7
1987	46,986,353	8,380,265	5.6
1988	48,080,021	8,799,882	5.5
1989	50,453,029	9,495,807	5.3
1990	48,847,290	9,440,732	5.2
1991	51,389,243	9,892,082	5.2
1992	53,070,637	10,408,742	5.1
1993	54,050,548	10,325,926	5.2
1994	52,897,589	10,251,074	5.2
1995	51,406,750	10,246,703	5.0
1996	50,501,927	10,259,605	4.9
1997	48,806,637	10,062,063	4.9
1998	49,540,083	10,590,082	4.7
1999	52,122,540	11,150,117	4.7
2000	53,415,883	11,667,739	4.6
2001	55,270,892	12,132,910	4.6
2002	56,300,480	12,443,521	4.5
2003	56,832,559	12,709,255	4.5
2004	58,100,661	13,195,307	4.4
2005	59,194,925	13,469,108	4.4
2006	59,938,349	14,002,770	4.3
2007	59,383,092	14,082,206	4.2
2008	63,314,539	15,178,364	4.2
2009	62,900,848	15,121,570	4.2
2010	62,695,395	15,377,917	4.1
2011	62,063,076	15,678,266	4.0
2012	64,308,815	16,438,781	3.9
2013	65,558,954	16,737,944	3.9
2014	64,493,290	16,880,672	3.8
2015	65,898,328	17,496,145	3.8
2016	68,526,907	18,363,822	3.7
2017	68,591,829	18,830,564	3.6
2018	71,838,887	19,836,250	3.6
2019	72,915,300	20,413,661	3.6

Table 15: Length of stay since winter season 1973/74 (STATcube, 2019b)¹⁸

¹⁸ Year 1974 refers to the 1973/74 winter season, and the same applies to all years.