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Climate Change Risk Appraisal in the Austrian Ski Industry

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Abstract

Ski tourism is an economically and culturally important industry in many parts of Europe. A growing number of studies in Europe, North America, Japan and Australia have concluded that climate change has potentially serious implications for the sustainability of ski operations by reducing the average length of ski seasons and, where applicable, increasing snowmaking costs. To date however, the climate change risk awareness and adaptive responses of stakeholders in the ski industry have not been examined. A survey of managers at low elevation ski areas in Austria was undertaken to explore their perceptions of climate change (past and future), how climate change had/will affect their operations, and their adaptive responses (past and planned). The results indicate that climate change is not perceived to be a serious threat to ski operations and that with technological adaptation, principally snowmaking, ski area managers believe they will be able to effectively cope with climate change in the 21st century. The consequences of these perceptions for the future operation of these ski areas are discussed and conclusions drawn for the future of ski tourism in Austria.

Keywords: climate change, technological adaptation, adaptive capacity, perception, ski resorts, winter tourism

Introduction

The United Nations Inter-governmental Panel on Climate Change (IPCC) Third Assessment Report (IPCC, 2001) concluded that, as a result of human activities, some climate change is inevitable in the 21st century, but that average temperature increases will be largely dependent on future greenhouse gas (GHG) emissions. [Schellnhuber et al. \(2006\)](#) conclude that even with drastic reductions in GHG emissions global temperature increases of 0.5-2°C are unavoidable. As a consequence, environmental systems and a wide range of economic sectors will have to adapt to climate change in the decades ahead. The tourism industry is no exception as it is highly reliant both on climate but also many climate-sensitive environmental resources (e.g., water levels, biodiversity, snow cover).

The current understanding of the consequences of global climate change for the tourism industry remains very limited ([IPCC, 2001](#); World Tourism Organization 2003; Scott et al. 2005; Gössling and Hall 2005). Furthermore, Scott (2006) argued that analysis of climate change adaptation is a critical knowledge gap in the literature on climate change and tourism and that the tourism sector is at least 5-7 years behind other economic sectors that have been actively engaged in adaptation research (i.e., agriculture - [Smit and Skinner, 2002](#), water resources - [de Loe et al., 2001](#), construction – Lowe, 2003).

The tourism segment where climate change impacts and adaptation research is most advanced is winter sports tourism. A number of studies from different nations (Australia – [Galloway, 1988](#); Hennessy et al., 2003, Austria - Breiling and Charamza, 1999, Canada - McBoyle and Wall, 1987, 1992; Scott et al., 2003, 2006; Scott and Jones, 2005, Japan - Fukuskima et al., 2003, Switzerland - König and Abegg, 1997; Elsasser and Messerli, 2001; Elsasser and Bürki, 2002; the United States - Lipski and McBoyle, 1991; Hayhoe et al., 2004, Casola et al., 2005, [Scott 2006](#)) have all projected negative consequences for the ski industry, though to varying degrees and over different time frames. A major limitation of the majority of these studies is that the adaptive capacity of the ski industry has not been assessed. Only [five](#) of the [16](#) studies cited above (Scott et al., 2003, 2006; Hennessy et al., 2003; Scott and Jones, 2005; and [Scott 2006](#)) have attempted to incorporate adaptations like snowmaking, which could have a sizable potential to reduce the projected negative impacts from climate change on the ski industry. As a consequence, the potential damages of climate change in many of the aforementioned studies may have been overestimated.

Adaptation in the tourism-recreation sector can be characterized as the combined actions (or non-actions) of various stakeholders, including individuals, businesses, governments, communities and non-governmental organizations. As the relevance of climate change for business planning is growing, tourism businesses should be expected to be at the forefront of adaptation measures [because of its high sensitivity to climate and climate sensitive-environmental resources](#). It is evident that climate change in coming decades might particularly jeopardize the sustainability of winter tourism, and more specifically low-lying ski operations. Ski resort managers have a central position in the supply chain of winter tourism, as they are in charge of transports (lifts, etc.) as well as the development and maintenance of ski runs. Ski resort managers [are also at the forefront of climate change adaptation as they](#) determine which adaptations are feasible (technically, economically, and politically) and when to implement them. Consequently, this study focuses on ski resort managers, their appraisal of the risks climate change poses to their operations, and what (if any) adaptive strategies they have taken or are considering for the future. Geographically, the research focus is on Austria, where ski tourism has great economic and socio-cultural importance.

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Climate change and ski tourism in Austria

Austria is a comparatively small country, with an area of 83,871 km² and a population of 8.1 million. Tourism is of great importance, with an estimated 19.4 million international tourist arrivals that generated receipts of €12.3 billion in 2004 (WTO, 2006). In terms of international tourist arrivals, Austria is now the 10th ranked tourist destination in the world (in 2004; WTO, 2006).

Tourist arrivals in Austria are relatively evenly distributed over the year (Statistik Austria, 2006), but, in contrast to most nations, winter tourism is of greater economic importance because average tourist spending is considerably higher during this season (Ministry of Economy, 2005). In 2004/05, an average winter tourist spent €99 per day, resulting in total spending of €4.73 billion in Austria by national and international ski tourists (Seilbahnen, 2006a). Ski resorts are also primarily found in rural areas, where they are known to generate multiplier effects through associated businesses, such as sport shops, ski schools, and hospitality and accommodations, helping to diversify local economies. The multiplier effects of ski tourism are estimated to create an additional economic impact of €2.58 billion (Seilbahnen 2006a). Any decrease in winter sport tourism as a result of global climate change, could thus have detrimental consequences for local and national economies in Austria.

The winter sports tourism industry is dependent on regular snowfall and favorable temperatures. Studies for Austria and Switzerland show that snow cover and the associated length of the winter season have declined since the 1980s (Latenser & Schneebeli, 2003). This trend is not linear though, with exceptions like the heavy snowfall winter of 2005/06, which resulted in comparatively long lasting snow cover even in low altitudes. These recent favorable winter sports conditions might at least partially be explained by periodical changes in the North Atlantic Oscillation (e.g. Pfister, 1999), but according to modeling studies, are not likely to prevail under climate change scenarios of the near future.

Analyzing long-term weather data from the Great Alpine Region (GAR), Auer et al. (2006) show that the GAR “warmed twice as much since the late 19th century compared to the global Northern Hemispheric average”. Importantly, warming trends have been equally pronounced in high and low elevation sites. In the future, temperatures in the central European Alps are predicted to increase even faster, with a 0.9-2.0°C annual warming expected in the 2020s, a 1.4-3.7°C warming in the 2050s and a 1.7-5.7°C warming in the 2080s (Parry, 2000). Skiing is dependent on a minimum snow depth. Even the most conservative scenario – warming of 0.9°C by 2020 – is projected to reduce natural snow cover by approximately four weeks at low elevations (~580 m) in the European Alps (Hantel et al., 2000). Breiling & Charamaza (1999) arrive at similar conclusions modeling snow cover depth in 34 Austrian districts under a 2°C warming scenario. Beniston et al. (2003) predict a reduction of 90% of snow cover in the European Alps at altitudes up to 1000m under a 4°C warming scenario by 2100. In Austria, a substantial number of ski resorts are located in relatively low elevations, including famous resorts such as Kitzbühel (800m a.s.l) and Schladming (745m a.s.l.), which are more vulnerable to the aforementioned changes in climate and snow conditions. Lower districts will experience lower mean snow cover and the mean altitude of ski lift starting points will need to move to higher altitudes. Importantly, changing natural snow conditions for skiing will primarily affect the beginning and end of the winter season, when economically important holidays of Christmas and Easter occur (Breiling & Charamaza, 1999). However, it should be noted that snowmaking and other adaptation strategies for the ski industry have not been considered in any climate change impact study in Austria.

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Method

An internet-based, structured questionnaire was sent to the managers of Austrian ski resorts in September and October 2005. Managers were defined as those authorized to make investments or strategic decisions at the respective ski resorts. Only resorts with a minimum 10 km of ski runs were included in the sample, as smaller ski areas are of limited economic importance. The study also focused on low-lying resorts, defined as having at least 50% of the skiable terrain below 1500m a.s.l. These elevations are projected to be more vulnerable to climate change and thus thought to have a greater awareness about climate change issues. The two criteria, minimum length of ski runs and percentage of skiable terrain below 1500m a.s.l., applied to 71 ski resorts out of a total of 306 in Austria (Bergfex, 2005). Of the 71 questionnaires sent out to managers, 36 were answered, representing a response rate just over 50%. No follow up procedures were employed with non-respondents. The questionnaire consisted of 21 different questions, including perceptions of current and future climate change, information sources on climate change, and adaptation strategies (current and planned). As not all questions were answered by all respondents, the sample size is in the following identified for each individual question.

Results

Managers of ski resorts were asked how important the issue of climate change was for their ski resort. Figure 1 shows that climate change is an important issue for ski resort decision makers with 56% ranking the issue as a high or moderately high priority. Only 3 of 35 (8%) ranked the issue as a moderately low to low priority.

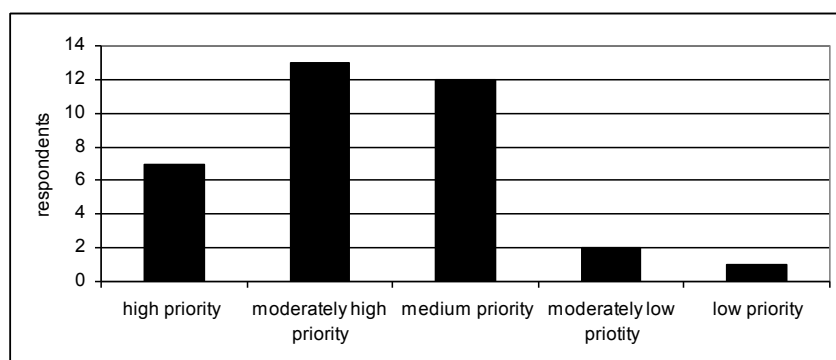


Figure 1: Importance of climate change for the future of ski resort (n=35)

When asked what their sources of information on climate change were, the majority of managers (89%) identified that the media as their source. Ski industry sources were the second most frequently mentioned information source (56%), followed by 'scientific information' (39%), which was clearly identified in the survey as information provided by the Intergovernmental Panel of Climate Change (IPCC) or comparable sources. One respondent also reported that he had attended climate change conferences. Although the dominant information source is the media, there is evidence that at least some managers have sought out more scientifically credible information sources on climate change.

Managers were asked in an open-ended question if any changes in climate had occurred in their area. Almost one third (9 out of 31) indicated that they had not observed any change in climate over the

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period they had worked at the ski area. Although most respondents based their answer on their personal perception of climate, some had investigated local climate trends using climate station records. For example, one respondent stated, “according to precipitation records, we are still more or less on the same level as in the past 70-80 years. Winters with little snow have also occurred in the 1920s and 1930s, and in the 1980s and 1990s.” This response also suggests that climatic change might in fact have been observed, but was not interpreted as a sign of human-induced climate change, but rather attributed to natural cycles in climate variability. Most respondents (59%) indicated that temperatures had increased and that the snowline had moved upwards in the past two decades. These changes had resulted in less snow, even though only 2 of 29 respondents specifically mentioned a shorter season as a consequence of recent climate change. Some respondents (21%) also believed changes had occurred in weather extremes such as storms, flooding and long periods without snowfall.

Respondents were then asked about their understanding of future climate change and consequences projected over the 21st century. A clear majority expects at least some substantial changes to occur, as only 25% of respondents believe that the climate will remain stable (“everything stays the same”; $x=3.47$ - on a Likert scale from 1 [very likely] to 5 [very unlikely]). The most probable climatic changes anticipated by ski area managers are increased extreme weather events ($x=1.97$) and less snow ($x=2.00$). Interestingly, 39% of respondents felt it was very to moderately probable that the ski season would be shortened by future climate change (‘earlier ending of the ski season’).

Few respondents believe that less tourists will visit the ski resorts ($x=3.28$) in future. Climate impacts are expected, but this does not necessarily mean that fewer tourists are believed to visit the area. This result seems to imply that respondents believe adaptation measures will buffer the impacts of expected climate changes.

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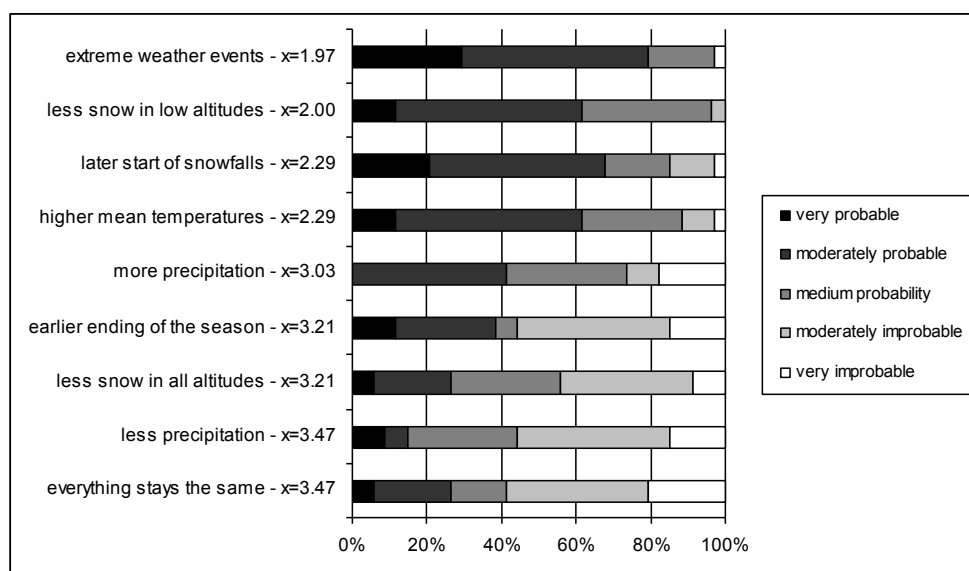


Figure 2: Perceived probability of future climate change and its consequences (n=30)

Managers were also asked whether **recent** climate change had resulted in higher operational costs. As shown in figure 3, most (56 %) managers reported “hardly any” or “no” economic costs. However, more than a third reported “medium economic costs”, and about 10% reported “moderately high” to “high” economic costs. Written comments suggest that snowmaking costs are increasing, but this could also be a result of attempts to stretch the ski season (i.e., not necessarily be a result of climate change). A qualitative indicator of costs was used in this question because dialogue with the ski industry suggested managers would not be willing to provide specific financial information about their business (either in Euros or percent operating costs).

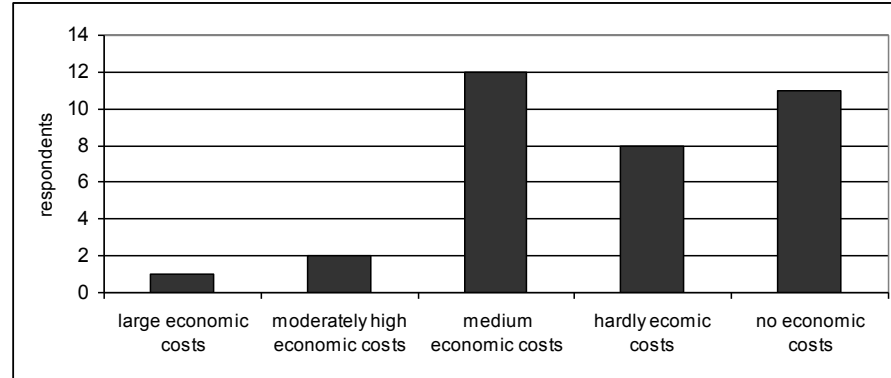


Figure 3: Observed economic costs as a result of **recent climate change (n=34)**

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The study's finding on ski area manager perceptions of climate change adaptation was particularly salient. Most ski area managers have considered climate change adaptation strategies and were highly optimistic about their capacity to negate the impacts of future climate change. Managers were first asked how long they expected their ski resorts to be economically viable without further adaptation measures if future climate change projections as they understood them were realized. Importantly, almost half (47%) indicated that their businesses would not be economically viable in 15 years without further adaptation and a large majority of ski area managers (88%) believed that their ski operations would not be viable 45 years from now without further adaptation. When further adaptation was considered, the managers' opinions about the sustainability of their ski area changed substantially. With further adaptation, about one quarter (24%) believed that they could operate their businesses for another 30-45 years, while almost half (44%) felt their businesses would continue to be viable for at least another 75 years. Only two ski area managers believed that even with further adaptation, their ski operations would no longer be viable in 15 years as a result of climate change.

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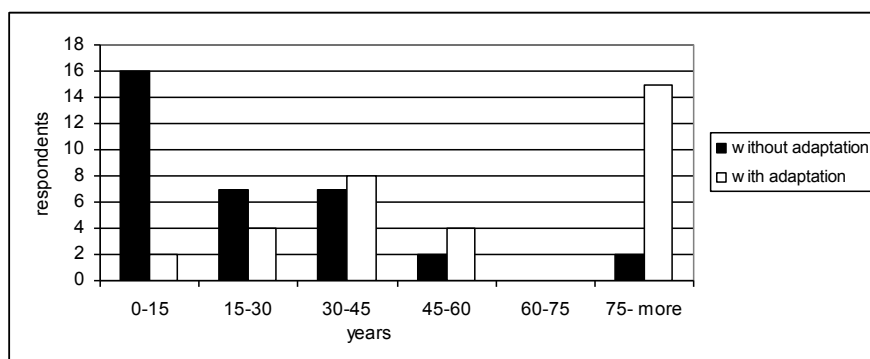


Figure 4: Expected economic viability of ski operations without (n=34) and with (n=33) further adaptation

Respondents were then asked to rate the appropriateness of a range of possible climate change adaptation strategies, that was based on a portfolio of adaptations (technological developments, soft business practices and government-industry policies) for ski areas developed by Scott (2005). Respondents were asked to rate each type of adaptation on a Likert scale (1 = very appropriate to 5 = not appropriate at all). Snowmaking was considered the most appropriate technological strategy to cope with climate change (figure 5), deemed "very appropriate" by 90% of respondents. Moving or expanding ski runs to higher elevations was the second most preferred option, followed by avoiding southern exposure of ski slopes. Respondents were split in their opinions of whether snowmaking with chemical additives and improving seasonal weather forecasts were appropriate or inappropriate adaptations. Technical adaptations considered inappropriate by the majority of ski area managers included shadowing of slopes by trees, artificial ski slopes, and cloud seeding.

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As shown in figure 6, "sharing the costs of snowmaking with the accommodation industry" is considered as the most appropriate business strategy for climate change adaptation, followed by "joining ski conglomerates", "diversification of winter products", "diversification of product throughout the season", and "enhanced marketing". These measures are seen as appropriate by a

majority of the respondents. In contrast, “shortening of the ski season” and “giving up slopes needing too much snow” were considered appropriate by only one-third of respondents. [Business](#) adaptations considered inappropriate by the majority of respondents were “increasing lift capacity”, “insurance”, “opening slopes with minimum snow cover” and “closing the ski resort”.

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Figure 7 shows ski area managers perspectives on government and ski industry responses. “Governmental subsidies for snowmaking” and “reviewing of environmental regulations” were preferred policy options, while climate change mitigation through lobbying to reduce emissions of greenhouse gases and “governmental support in case of economic losses” were seen as moderately appropriate.

When all types of adaptation are considered, snowmaking was the most widely accepted adaptation strategy ($x=1.26$), while “sharing snowmaking costs with the accommodation industry” ($x=1.65$) and “moving ski runs to higher altitudes” ($x=1.91$) were the second and third most accepted adaptation options. This finding stands in contrast to Elsasser and Messerli (2001), whom suggest that shifting ski areas to higher elevations is the most prevalent adaptation strategy in Switzerland.

An open-ended question was used to identify what respondents believed to be key barriers to climate change adaptation. The most common response was financial constraints. Some ski area managers indicated that while adaptations like snowmaking could keep ski areas physically operational, eventually the additional costs may exceed customers’ willingness to pay. Some managers were aware that under the warmest climate change scenario, snowmaking may not be technically feasible and would be more costly. One respondent criticized the accommodation industry, which has not been willing to share the costs of snowmaking, even though it profits from having ski areas open and more tourists. This points to a structural weakness in the winter tourism segment in Austria (and many other parts of Europe), that makes the ski industry more vulnerable to [climate change](#) than some areas of North America where the ski resorts (accommodations, retail, lessons, rentals, ski lifts, etc.) are fully integrated under a single business enterprise. Two respondents also mentioned that government regulations in Austria were a barrier to adaptation, as they prevented certain adaptation options, such as opening new ski terrain at higher elevation or using snowmaking additives that allow snowmaking at warmer temperatures. Another respondent stated that competition between ski resorts is already tough and will increasingly disadvantage smaller resorts in the future because of limited financial resources and the inability to compete with “aggressive” investments of [large](#) resorts.

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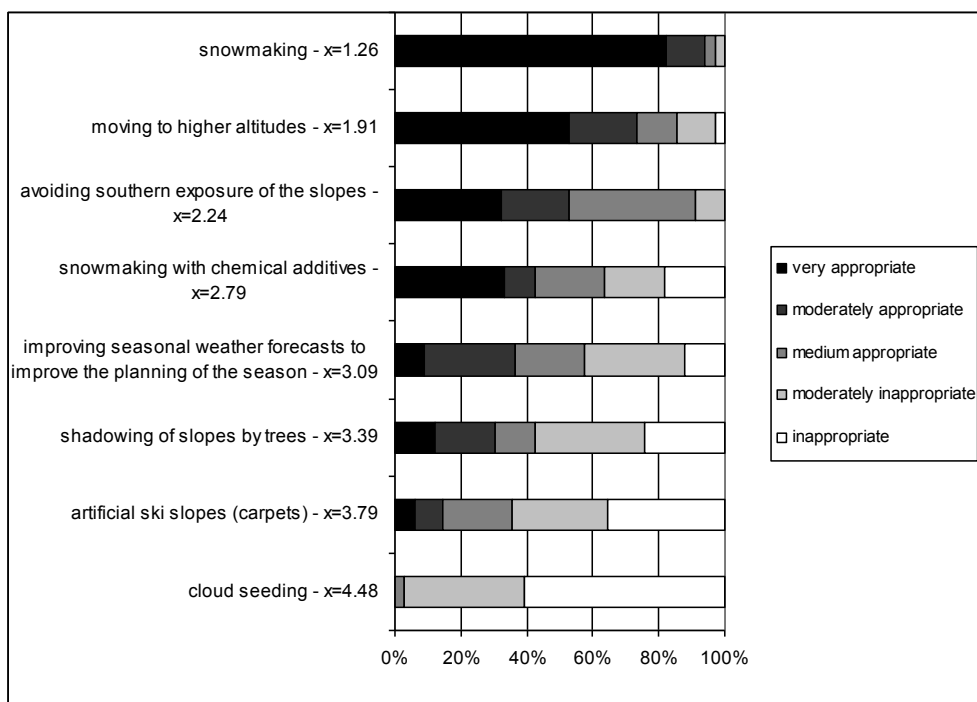


Figure 5: Ski area manager attitudes towards hard technological adaptations (n=34)

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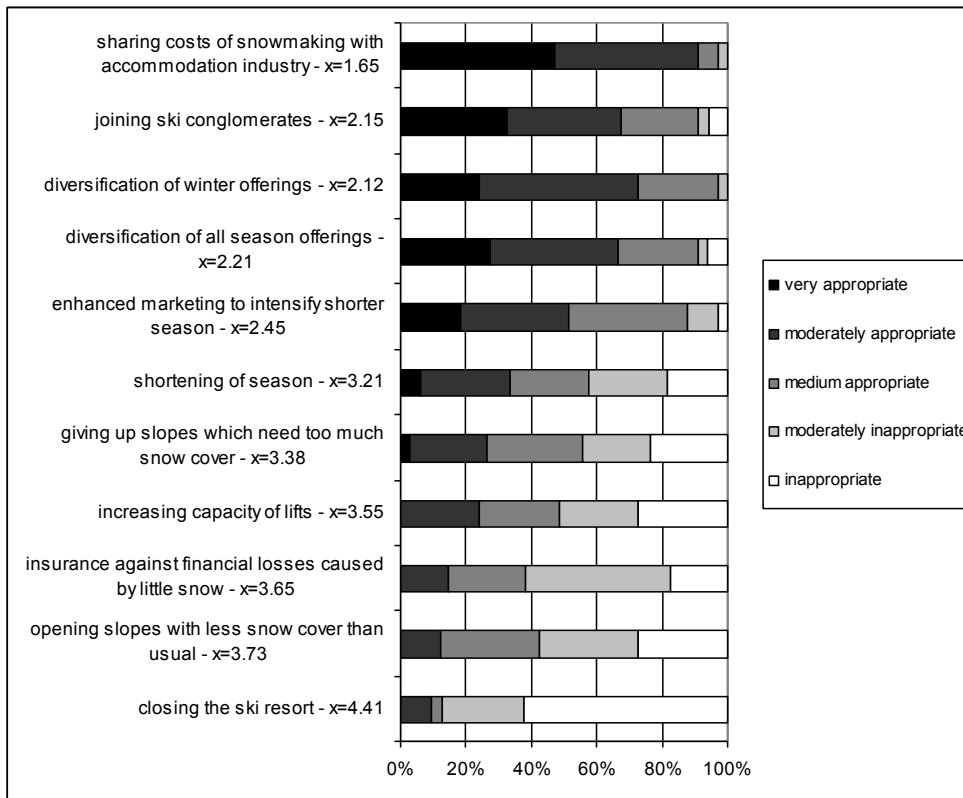


Figure 6: Ski area manager attitudes towards business adaptations (n=33)

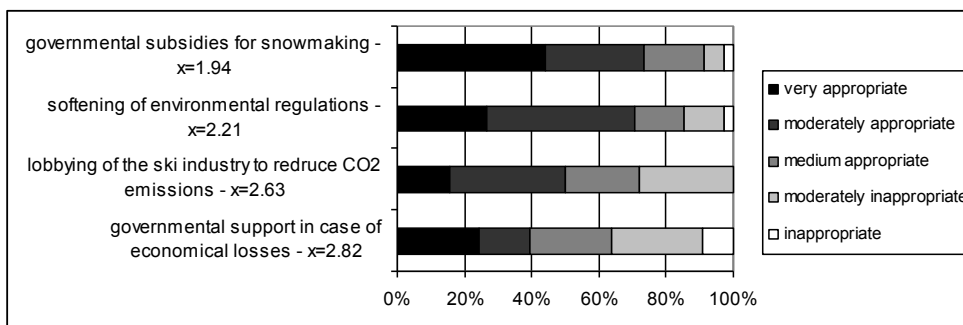


Figure 7: Ski area manager attitudes towards government and ski industry adaptations (n=32)

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Discussion

This study found that the managers of low-elevation Austrian ski resorts are aware of the challenges that projected climate change represents for their business operations. Nonetheless, the majority of

ski area managers did not perceive climate change to be a substantial threat ('risk appraisal'), because most believed that adaptive strategies, such as snowmaking, would be sufficient to cope with climate change during the 21st century. Without further adaptation, almost half of the ski area managers believed that their ski operations would not be sustainable in 15 years. With further adaptation, the majority of managers thought their ski operations would remain economically viable for at least another 75 years. These results clearly show the importance of climate change adaptation to ski area managers, yet with the exception of [Scott et al. \(2003, 2006\)](#) in Canada, [Hennessey et al. \(2003\)](#) in Australia, and [Scott \(2006\) in the United States](#), adaptation has not been incorporated into climate change assessments of the ski industry.

Snowmaking is the most important climate adaptation in use currently and planned for the future. More than half of the ski areas in this study already use this technology on 80% or more of their ski runs. Seilbahnen (2006a) stated that Austrian ski resorts spend [approximately](#) €120 million in snowmaking on a yearly basis and the investment in snowmaking is increasing (€ 144 [million](#) were planned for 2004/05). Snowmaking appeared to be the dominant strategy planned by ski area managers to cope with future climate change and it therefore deserves further analysis in the future. For example, no analysis has yet been undertaken in Austria to determine whether ski area managers have over-estimated their capacity to make snow under warmer climate change scenario or the planning implications of increase snowmaking ([e.g., increased water usage](#)).

A number of other adaptation strategies were also deemed appropriate by the majority of ski area managers, including "moving ski runs to higher elevations", "avoiding southern exposure of ski slopes", "sharing costs for adaptation with accommodation industry", "joining ski conglomerates", "diversification of product", "enhanced marketing to intensify shorter season", "government subsidies", and "softening of environmental regulations." The differential support for individual adaptation options found in this study supports Scott's (2006) supposition that climate change adaptation will differ among ski resorts based on their physical characteristics, business model and, as this survey revealed, management preferences.

The responses of ski area managers on the appropriateness of individual adaptation options and key barriers to adaptation provide important insight into how low-lying Austrian ski areas and perhaps ski areas in other parts of the Alps are likely to respond to climate change in the decades ahead. The findings [have implications for government policy and planning as well as for future research](#). The most commonly supported adaptations should be the focus of future government policy discussions regarding the sustainability of the Austrian ski industry and winter tourism. Should the government develop a program to subsidize the capital costs of implementing snowmaking systems? Should income-stabilization programs be created for the ski industry, like in agriculture, so that during years when the operational costs of snowmaking are much higher, the costs are partially offset by government? Conversely, should the government policy be to provide no assistance to low-lying ski areas, but allow existing low-lying ski area owners to exchange their lands for new ski area development at high elevation? What are the implications of not supporting climate change adaptation in the ski industry, especially if competing nations do support their national ski industry? There are also local planning implications of the adaptation strategies that the results suggest are most likely to be pursued by ski area managers. Securing future water supplies for additional snowmaking is something most ski areas will need to resolve through access to natural water bodies or permits to construct larger water reservoirs. However, what are then the environmental implications of additional snowmaking or the introduction of snowmaking additives? Do local landowners and communities find potential impacts acceptable? The closures of local ski areas or

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change in ownership as ski areas join multi-national ski conglomerates also have implications for employment and local economies. Finally, as Scott (2006) indicated, adaptation is an underdeveloped theme in the climate change and tourism literature, and the climate change research community must develop methods to incorporate the adaptations supported by the majority of ski area managers into future vulnerability assessments of the Austrian ski industry.

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