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Abstract

For many alpine areas in Switzerland, winter tourism is the most important source of income, and snow-reliability is one of the key elements of the offers made by tourism in the Alps. 85% of Switzerland's current ski resorts can be designated as snow-reliable. If climate change occurs, the level of snow-reliability will rise from 1200 m up to 1800 m over the next few decades. Only 44% of the ski resorts would then still be snow-reliable. While some regions may be able to maintain their winter tourism with suitable adaptation strategies, others would lose winter tourism due to a diminishing snow pack. Climate change must be viewed as a catalyst that is reinforcing and accelerating the pace of structural changes in tourism. Today, adaptation strategies are predominant in tourism (e.g. artificial snow production). As an industry that will be severely affected by climate change, however, tourism will increasingly have to focus on mitigation strategies (e.g. less greenhouse gas emissions by tourism traffic).
CLIMATE CHANGE AND TOURISM IN THE ALPINE REGIONS OF SWITZERLAND

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ABSTRACT
For many alpine areas in Switzerland, winter tourism is the most important source of income, and snow-reliability is one of the key elements of the offers made by tourism in the Alps. 85% of Switzerland’s current ski resorts can be designated as snow-reliable. If climate change occurs, the level of snow-reliability will rise from 1200 m up to 1800 m over the next few decades. Only 44% of the ski resorts would then still be snow-reliable. While some regions may be able to maintain their winter tourism with suitable adaptation strategies, others would lose winter tourism due to a diminishing snowpack. Climate change must be viewed as a catalyst that is reinforcing and accelerating the pace of structural changes in tourism. Today, adaptation strategies are predominant in tourism (e.g. artificial snow production). As an industry that will be severely affected by climate change, however, tourism will increasingly have to focus on mitigation strategies (e.g. less greenhouse gas emissions by tourism traffic).

KEYWORDS: Alps, Climate change, Skiing, Snow, Switzerland, Tourism

INTRODUCTION
For many alpine areas in Switzerland winter tourism is the most important source of income, and snow-reliability is one of the key elements of the touristic offers. Skiing and snowboarding, but also snow related activities like cross-country skiing or snow hiking depend on enough snow. Hence, the financial viability of the winter tourism industry depends on sufficient snow conditions. It was the winters with little snow at the end of the Eighties (1987/88 – 1989/90) that caused a stir in the Swiss Alps. The big difference to the situations at earlier periods with little snow is that the capital intensity of ski tourism had considerably increased.

Since 1850, Swiss Glaciers have lost more than a quarter of their surface. In 2030, 20 to 70% of
Swiss glaciers will have disappeared. This is not only a severe lost of mountain aesthetic, but also a problem for ski slopes on glaciers in winter and summer skiing.

Global warming increases melting of permafrost and makes many mountain areas vulnerable to landslides. Mountain cableway stations lift masts and other buildings in permafrost soil become instable. To brace such buildings in melting permafrost causes high costs. However, warming in mountain areas also makes hiking and climbing more dangerous due to increasing rock fall. On the one hand, the future climate will be warmer on the other hand the future climate will change its pattern. More precipitation or a higher fog level will lead to new conditions for mountain summer tourism such as hiking, trekking or biking. More and stronger extreme events are another threat for tourism activities and tourism infrastructure.

Because of the strong links of tourism and agriculture, direct impacts of climate change on tourism or agriculture are likely to have additional indirect impacts on the other sector. Depending on the region, farmers rely to a variable degree on off-farm income. In the Swiss Alps, an important number of the farmers depend on winter tourism. This is important because government subsidies and the total gross margin could change in the future independent of climate change, whereas additional income from activities in other sectors, such as winter tourism, may change because of climate change. Direct impacts of climate change on the tourism industry may have serious indirect effects on agriculture. Climate change is not only a severe threat for winter tourism, but for alpine agriculture too.

**CLIMATE CHANGE AND SNOW-DEFICIENT WINTERS**

The Swiss economy is highly dependent on tourism. If the assumptions of the impacts of climate change hold true, snow cover in the Swiss Alps will diminish which will, in turn, jeopardise the tourism industry. The crucial factor for the long-term survival of mountain cableway companies is the frequency and regularity of winters with good snow conditions, or, put the other way round, the number of snow-deficient winters that can be withstood. It is not possible to give a definitive answer here, since the economic situation of the companies varies too much. The experience acquired by Swiss ski resorts, however, shows that a ski resort can be considered snow-reliable if, in 7 out of 10 winters, a sufficient snow covering of at least 30 to 50 cm is available for ski sport on at least 100 days between December 1 and April 15.

Today, 85% of Switzerland's 230 ski resorts can be considered to be snow-reliable (tab. 1).
However, even today a lot of ski resorts in the Prealps are not snow-reliable. If the line of snow reliability were to rise to 1'500 m as a result of climate change (year 2030 – 2050), the number of snow-reliable ski resorts would drop to 63%. The Jura, Eastern and Central Switzerland, Ticino, and the Alps in the cantons of Vaud and Fribourg will be particularly jeopardised by global warming. The ski regions of Valais and the Grisons will experience virtually no major problems, since the mean altitude of the cableway terminals in these regions is higher than 2500 m above sea level. If the line of snow-reliability were to rise to 1800 m, which is a possible scenario, there would be a further serious deterioration in conditions: only 44% of skiing regions could be designated as snow-reliable. Even in the cantons of Grisons and Valais, approximately a quarter of the ski resorts would no longer be snow-reliable.

Table 1: Snow-reliability of Swiss ski resorts (Abegg 1996, Buerki 2000)

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of ski resorts</th>
<th>1200 masl No. %</th>
<th>Snow-reliability 1500 masl No. %</th>
<th>1800 masl No. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jura</td>
<td>15</td>
<td>4</td>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>Alps (Vaud + Frib.)</td>
<td>19</td>
<td>16</td>
<td>84</td>
<td>7</td>
</tr>
<tr>
<td>Valais</td>
<td>54</td>
<td>54</td>
<td>100</td>
<td>52</td>
</tr>
<tr>
<td>Bern (ex. Jura)</td>
<td>35</td>
<td>30</td>
<td>86</td>
<td>20</td>
</tr>
<tr>
<td>Central Switzerland</td>
<td>35</td>
<td>26</td>
<td>74</td>
<td>13</td>
</tr>
<tr>
<td>Ticino</td>
<td>8</td>
<td>8</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>Eastern Switzerland</td>
<td>18</td>
<td>11</td>
<td>61</td>
<td>6</td>
</tr>
<tr>
<td>Grisons</td>
<td>46</td>
<td>46</td>
<td>100</td>
<td>42</td>
</tr>
<tr>
<td>Switzerland</td>
<td>230</td>
<td>195</td>
<td>85</td>
<td>144</td>
</tr>
</tbody>
</table>

Climate change will lead to a new pattern of favoured and disadvantaged ski tourism regions. If all other influencing factors remain the same, ski tourism will concentrate in the high-altitude areas that are snow-reliable in the future too, e.g. most of the ski runs in the cantons of Valais and Grisons. Ski resorts at lower altitudes will withdraw from the market sooner or later because of the lack of snow.
The only areas with good prospects will be those with transport facilities that provide access to altitudes higher than 2000 m. The regions at higher altitudes may experience greater demand, prompting a further expansion in quantitative terms. The pressure on ecologically sensitive high-mountain regions will increase. The call for snow-reliable ski resorts constitutes the main reason for the current boom in concept studies and plans for opening up high-mountain regions, or, expressed in different terms: climate change is an argument for opening up high-mountain regions to tourism. A survey among tourists shows, that skiers will respond flexibly to changing snow conditions. During a period of snow-poor seasons, as expected more often under a changing climate, 49% of the skiers would change to a ski resort that is more snow-reliable. 32 % of the skiers would ski less often. Although only 4% of the respondents would give up skiing, it can be concluded that climate change would have serious impacts on the number of skier days. The most vulnerable ski resorts in the lower regions of the Alps have to deal with a significant decrease of younger guests, day tourists and novice skiers, which is exactly the target group of these resorts (Buerki 2000).

Meier (1998) calculated the potential annual costs of climate change in Switzerland at CHF 2.3 to 3.2 billion (US $ 1.5 to 2.1 billion) by the year 2050, which is 0.6 to 0.8% of the Swiss gross national product for 1995. CHF 1.8 to 2.3 billion (US $ 1.2 to 1.6 billion) would be accounted for by tourism. Even if there are many reservations that can be voiced regarding this calculation, it nevertheless shows that tourism is the economic sector that would be most affected by climate change in Switzerland and that this influence is of an order of magnitude that cannot be neglected. The impacts of climate change on winter tourism may be even more severe in countries such as Germany or Austria due to lower altitudes of their ski resorts.

However, the winter of 1998/99, in particular, February 1999, showed that the possibility of winters with a great deal of snow can not be excluded in the future. In a study of the ‘avalanche winter’ of 1999, the direct losses incurred by mountain cable-ways as a result of avalanches and the large quantities of snow were estimated at CHF 17 million (US $ 12 million). In total, 44 facilities were damaged, including 20 skilifts, 11 chair-lifts, 4 cable railways and 2 funicular. The mountain railway companies had to spend an extra 77% on snow clearing, compared with previous years. Roughly 25% more than in normal winters was spent on securing the ski slopes. All in all, the avalanche winter of 1999 probably caused losses of CHF 332 million (US $ 240 million), the major portion of these having been indirect losses of CHF 302 million (US $ 215 million) (Nöthiger 2004 & SLF 2000).
ADAPTATIONS OF TOURISM REPRESENTATIVES

In Switzerland the tourism representatives at a political, entrepreneurial, operational and organisational level are not sitting back idly contemplating the consequences of a climate change. They are adapting right now in the expectation of climate change. The experiences with snow deficient winters have shown them that the climate does not determine their economic activities, but, instead, constitutes a key resource and framework condition. The results of a focus group study among tourism representatives in Switzerland can be summed up as follows:

- Climate change has been recognised as a problem for winter tourism. Those responsible for tourism know that what they can offer is highly dependent on snow and that they are at risk from snow-deficient winters. They are familiar with the potential consequences of climate change for winter tourism. While achieving snow-reliability constitutes a central topic, potential climatic change is seen as being only of relatively minor importance.

- Climate change is not regarded as a catastrophe for winter tourism. The tourism representatives think that climatic change is presented in a highly exaggerated form by the media – and also in science and politics. Although climate change could intensify the problems that already exist in ski areas at lower altitudes and speed up structural changes in the sector, the majority of ski resorts at medium and high altitudes, however, would scarcely be affected.

- Climate change is already affecting the strategies and plans of the winter sport resorts today. The discussions held in the focus groups clearly revealed an ambivalent relationship to climate change. On the one hand, the representatives strongly distrust the information disseminated about climate change and play down its potential consequences, but on the other hand, they use climate change to legitimate forward strategies. Climate change and global warming, together with international competition, have been used as the key arguments for constructing artificial snowmaking facilities, as well as for extending existing ski runs and opening new ones in high-alpine regions (at above 3000 m).

- The tourism representatives all agree that winter sports can only survive in the Alps if snow-reliability is guaranteed. Precisely, the smaller ski fields at lower altitudes either have their hands bound or can scarcely finance the necessary investments (e.g. snow cannons, levelling out ski slopes, opening higher-altitude chambers in skiing areas). On the one hand, they do not have financial resources of their own, and on the other hand, banks are (now) only
prepared to grant very restrictive loans to ski resorts at altitudes below 1500 m which are not particularly profitable. Nevertheless, the representatives believe that smaller ski fields in the Alpine foothills play a key role in promoting the importance of skiing. Opinions frequently differ a great deal, however, on whether nonprofitable ski regions of this type should be retained and how their financing can be guaranteed. While a number of people are in favour of dismantling non-profitable cableway and ski-lift operations and regard a certain ‘healthy shrinkage’ of the sector as necessary, others believe that there is an obligation to retain these ski fields for regional economic reasons. This is also increasing pressure for cable-way companies to receive subsidies.

**STRATEGIES**

Climate change represents a new challenge for tourism, and particularly for winter tourism in mountain areas. It is not, however, the case that tourism’s initial position will undergo a sudden, radical change. Instead, climate change has to be viewed as a catalyst that will reinforce and accelerate the pace of structural change in the tourist industry and more clearly highlight the risks and opportunities inherent in tourist developments even now. The emergence of a 2-tier society in the tourist sector will not be due to climate change alone, but to the general change in structure as well. On the one hand, we have the top resorts with their already varied and attractive offers and high snow-reliability and, on the other hand, we have the smaller locations with their less extensive developments, less-refined offers and restricted opportunities for further development. Since climate change is a relatively long-term development in comparison to other trends in tourism, tourism managers and tourists will have every opportunity to adjust to the different constraints and adopt the corresponding strategies and measures (fig. 1):

One of the most familiar measures in the struggle against snow-deficient winters is the construction of high cost artificial snowmaking facilities.

Adopting a fatalistic attitude towards climate change and its impacts should not be considered as a true strategy in this respect. Such attitudes are manifested by the fact that neither suppliers nor consumers alter their behaviour. This could also be described by using the term ‘business as usual’.

Another approach that can be classified under the heading of ‘fatalism’ is when tourist transport facilities that were used for winter sports are closed down and dismantled without any attempt at promoting and reinforcing other types of tourism – in other words, when withdrawal from ski
tourism is not actively planned. A fatalistic attitude of this type is most readily evident amongst the operators of small, isolated ski-lifts at lower altitudes who experienced severe financial difficulties as a result of the snow-deficient winters.

Figure 1: Adaptation strategies

CONCLUSIONS
At first sight, global warming seems to be a chance for the tourism industry in alpine areas. But warmer temperatures and a longer summer season are of minor importance. Overall, climate change is a threat for alpine tourism due to less snow, less glaciers, but more extreme events (e.g. landslides).

Winter tourism depends on good snow conditions and is highly sensitive to snow-deficient winters. Climate research findings show that there will be an increase in the number of winters with little snow on account of climate change. The tourism representatives will not just sit back idly in the face of climate change. They are reacting to the deteriorating snow conditions and the changes in demand. Technical measures, especially artificial snowmaking, to maintain ski tourism rank at the forefront. Tourists demand good snow conditions, and hence, this is what has to be offered by the ski resorts. In any case, the impacts of climate change will involve significant costs for tourism. One
of the most important questions will be, how young people would start skiing/snowboarding, if there is only little snow in the big towns and if the little and cheap ski lifts for families at small distances to these towns will be dismantled due to climate change. Although indoor skiing is a growing industry in European towns, it is uncertain that indoor ski domes can replace the role of little ski resorts for beginners in the foothills.

As a sector of the economy that is severely affected by climate change, however, tourism needs to focus more on mitigation strategies in its own best interests. This holds particularly true for the traffic generated by national and international tourism and, above all, for air traffic. Tourist development and tourist projects not only need to be verified and evaluated in terms of their social and environmental compatibility but must also be assessed from the climate-compatibility angle.

REFERENCES