The ‘Optimal Skiing Day’: The future of ski resorts under climate change conditions

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ABSTRACT: The purpose of this presentation is to implement and apply a model permitting to identify and assess the most economical days of a skiing season in order to determine the future profitability of ski resorts in a differentiated way. As they are both an important winter sport destination and particularly vulnerable to climate change the Alps were chosen as area under investigation to simulate their development under climate change conditions. The simulation results support the presumption that a seasonal shortening as well as temporal shift of optimal skiing days manifest. The presented model provides ski resort specific numbers of profitable days instead of rules of thumb for the breakeven point of general opening days. This aspect is particularly important to deal with today with a view to well-founded long term decisions concerning the strategic direction of ski resorts.

Keywords: climate change, skiing tourism, profitability, modeling, Christmas-Easter-shift

1 INTRODUCTION

Future ski tourism is strongly influenced by climate change. The economic success of ski tourism regions depends on both the quantity and the quality of the ski resorts' opening days. The ski tourism industry in the Alps is very heterogeneous concerning the size, structure and profitability of ski areas and their adaptability to climatic changes (Abegg and Elsasser, 2007). While ski resorts which are well equipped, located at high altitudes and therefore rated as snow-reliable are very mostly successful, smaller ski areas in disadvantaged locations often operate in the red. Since ski area operators largely depend on the quality and quantity of snow conditions, they are highly sensitive to snow deficient winters (Falk, 2011) and the number of opening days. Nevertheless, up to now, there is very little research about the quality of ski season opening days.

To assess the profitability of ski areas, the literature refers to the 100-day-rule (Witmer et al, 1986). This rule states that a ski resort reaches its break-even point if snow-reliability (snow depth of at least 30 cm for alpine skiing) is given on 100 days per season. If this condition is met in seven of ten consecutive years, the ski area is said to be economically viable. Abegg (1996) points out that the 100-day-rule functions as a reference point for practitioners.

In addition, tourism practitioners are not only interested in the number of open days per season, but also the intraseasonal distribution and the quality of an open day are important (Fukushima et al, 2002). In the light of a changing climate, a ski area's particular future development could be assessed in a more realistic way using knowledge of these additional factors in a new key figure.

The quantity and distribution of open days within a season are simulated in a fully coupled simulation system developed in the interdisciplinary project GLOWA-Danube (www.glowa-danube.de). In this ten year research project (2001 to 2010) funded by the German Federal Ministry of Education and Research, the effects of climate and societal change on a broad range of sectors, such as tourism, households or farming have been intensively analysed (Barthel et al, 2008). For that purpose, different climate and societal scenarios (Soboll and Schmude, 2011) can be simulated within the period between 2011 and 2060. By the use of different scenarios, a wide range of possible future developments can be investigated. Simulations are run for the Upper Danube catchment, an area of 77,000 km² including parts of Germany, Austria and Switzerland (Mauser et al, 2008).

2 THE MODEL OF AN “OPTIMAL SKI DAY” (OSD)

Essentially, climatic factors determine whether a ski area might open on a certain day. Moreover, if these factors generally allow for opening, the quality of the respective day is of importance.

The selection of variables that make up the OSD is based on a comprehensive literature review and the model requirements outlined above. It has been validated in terms of fifteen expert interviews with selected stakeholders, including ski lift operators, chairmen of skiing clubs, ski instructors and representatives of tourism associations. Table 1 sketches the factored variables and their required values. Only when a day meets all of these conditions concomitantly, is it categorised as OSD.

variable	value
precipitation	= 0 mm
operating state	ski area completely operating
(artificial) snow depth on slopes	≥ 30 cm
surrounding snow coverage (scene function)	> 0 cm
perceived temperature	between -5 and +5 °C
sunshine duration	≥ 5 h/day
wind speed	≤ 10 m/s
type of day	weekend day/holiday

Table 1: “Optimal Ski Day”: considered variables and required values

An OSD requires rainlessness or snowlessness. Moreover, for an OSD, we expect all slopes of the ski area to be opened. In addition, according to Hall and Higham (2005) who list several ideal climatic conditions for alpine skiing, a minimum snow depth of 30 cm is required. This snow blanket may consist of natural or artificial snow. Additionally, full snow coverage of the surrounding landscape is necessary for a pleasant scenery (Tuppen, 2000). Though this is more of a psychological aspect, it is considered of importance for the perception of a day as an OSD. This factor becomes more obvious if one imagines a white strip of artificial snow amid barren brown surroundings.

There are different indexes to characterise the thermal bioclimate on a thermal sensation scale, among them the “physiological equivalent temperature” (PET) (Matzarakis et al, 1999). For an OSD, the consulted experts valued a band of pleasantly perceived temperatures from -5 to +5 °C. This corresponds to a slightly cool thermal perception of PET. The perceived temperature depends among other things directly on the daily sunshine duration. We rate a day as an OSD if the local actual sunshine duration is at least five hours. Moreover, we identified a maximum wind speed of 5 meters per second (18 km/h) as a climatic requirement for an OSD, according to the literature (Hall and Higham, 2005) and the experts we consulted.

Finally, all interviewees confirmed the relevance of the type of day for the parameter OSD. This is due to the fact that on days which meet all of the above mentioned requirements and are in addition a weekend day or holiday, a considerably higher number of visitors and thus more turnover can be expected.

After having defined the OSD, a positive linear correlation between the number of OSD and the turnover is set up. Figure 1 schematically points out the turnover of a fictional ski area for three numbers of OSDs (0, 15 and 30 OSDs) depending on the total number of open days per season. The green line (0 OSDs) represents the commonly used 100-day-rule. In this case, it can be assumed that per open day, 1 percent of the necessary turnover is generated when reaching the break-even point at the hundredth open day. On the supposition that the quality of an open day has a decisive influence on the number of visitors and therefore on the turnover, an OSD is more valuable for a ski lift operator than a “normal” open day. At a given weighting factor of 2, implying that the turnover is two times higher at an OSD compared to a “normal” open day, the fictional ski area reaches the break-even point after about 77 days, if fifteen of them are OSDs (blue line). In case of 30 OSDs (red line), cost coverage is achieved already after approximate 62 open days. This weighting factor can be set by the particular ski lift operator according to the specific conditions of his ski area.

Subsequently, we validated the OSD range of climate variable values by comparison with reference data from the German Meteorological Service (2011). For instance, the Zugspitze ski resort (administrative district Garmisch-Partenkirchen, Germany, located between 2,057 and 2,962 meters above sea level) reaches in the simulation on average 33 OSDs per season during the decade of the 2010s. Reference data for the period from 2006 to 2009 give an average of 30 OSD-equivalents. As the review of other ski areas led to similar results, we consider the included variable values confirmed.

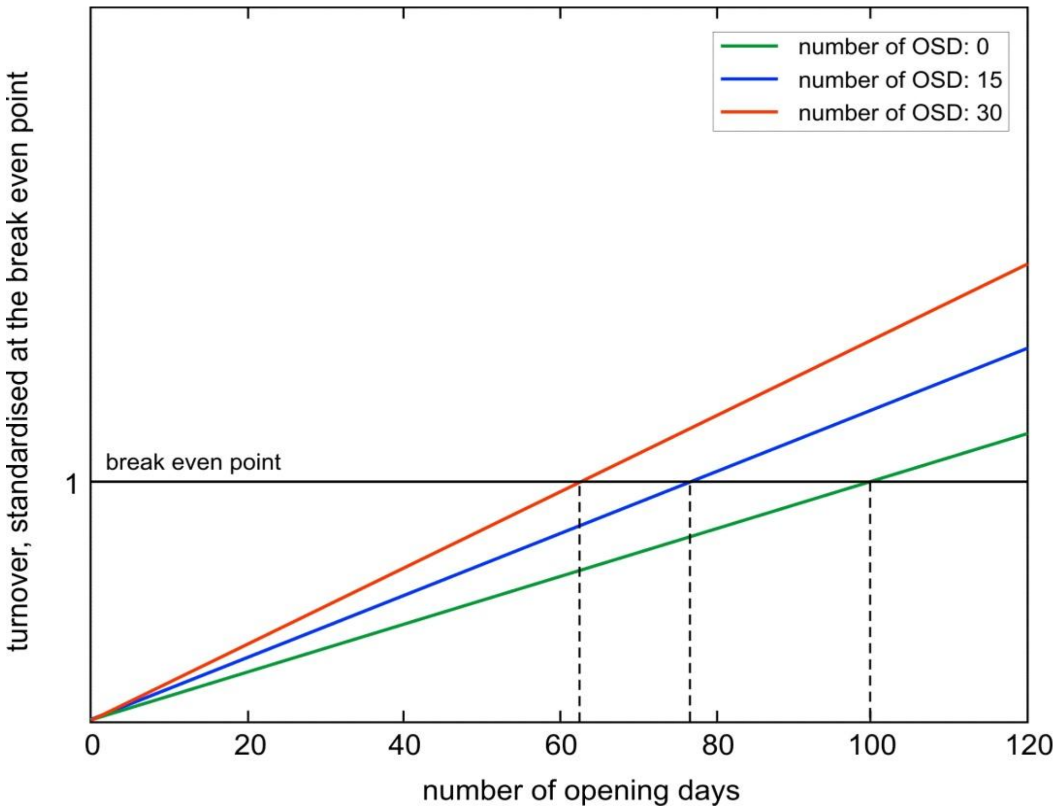

Figure 1: Number of open days, number of OSDs and the achievement of break-even point in one season (exemplary for 0, 15 and 30 OSDs)

3 FIRST RESULTS

Initial results of six different climate scenario simulations show a strongly differentiated regional picture of the occurrence of OSDs even in the first simulation decade, the 2010s: ski areas in the investigation area reach between 2 and 16 OSDs per season on average. In figure 2 the number of OSDs is aggregated on the district level, so that spatial differences become more distinct. It tendentially shows a north-south gradient.

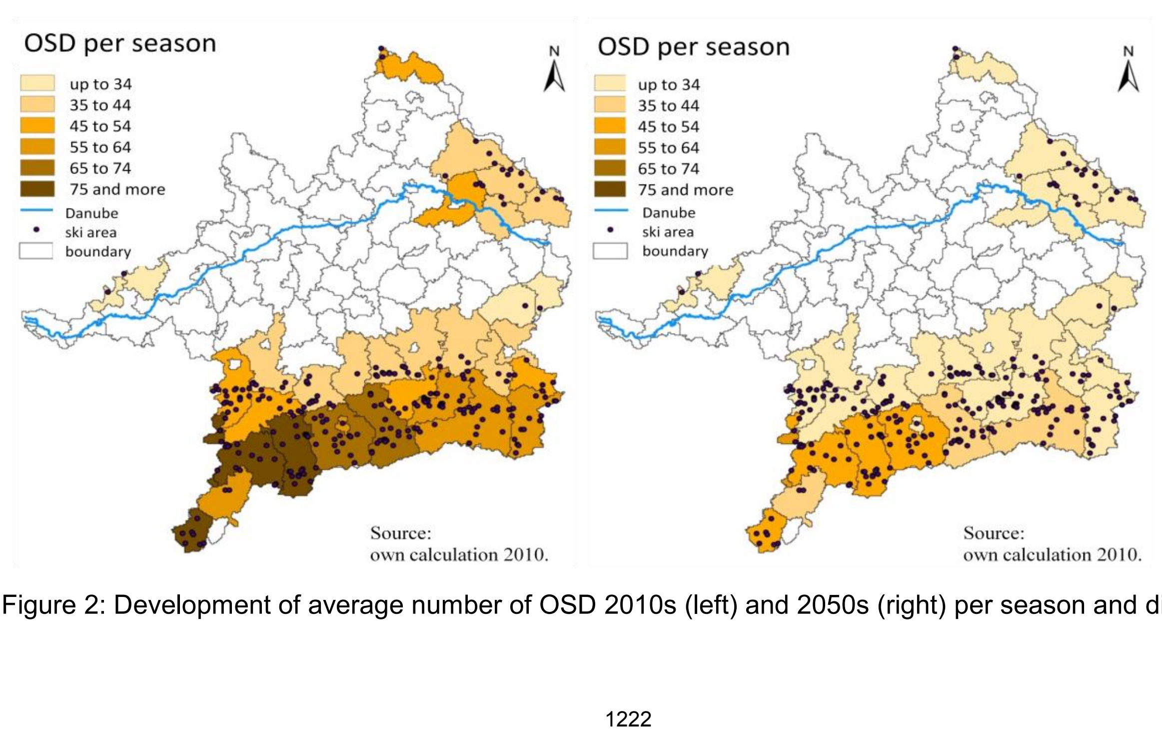

Figure 2: Development of average number of OSD 2010s (left) and 2050s (right) per season and district

Interseasonal development: Throughout the simulation period, the absolute number of OSDs decreases over the entire investigation area. The average percentage deviation per administrative district in the 2050s seasons compared to the 2010s seasons amounts to between –35 and –91 percent - but the spatial distribution of OSDs per seasons turns out to be relatively stable (Spearman coefficient 0.92 for $p < 0.01$). In the southern half of the investigation area, those ski areas which currently reach the highest numbers of OSDs per season will probably also be in the leading group in future.

Intraseasonal distribution: To illustrate this aspect, one ski area in Berchtesgadener Land, the south easternmost administrative district of Bavaria/Germany is selected. This ski area is located between 900 and 1,300 meters above sea level. For this ski area, we have run simulations with six different climate trend-combinations to show the range of possible future developments. Figure 3 shows the average share of OSDs per month on all OSDs per season (December to April). To minimise potential impacts of outliers, we averaged the results for every decade. The lines represent the respective average of these six scenario results. For clarity reasons, only the results for the 2010s, 2030s and 2050s are depicted.

Already within the relatively short time span of the next fifty years, a trend towards a temporal shift of OSDs in terms of an intraseasonal postponing is evident. This shift is due to climate change effects including alterations of precipitation patterns and a tendentially later occurence of freezing days in the ski season. Averaged over the 2010s, the OSD-peak lies in December and January with, jointly, about 60 percent of the seasonal count of OSDs (blue line). Also for February, the share is relatively high in the 2010s. Meanwhile, in the second half of the season, the monthly shares of OSDs slump. The 2030s seasons already show considerable differences compared to the 2010s: the seasonal distribution of OSDs becomes broader, and December, March and April reach approximately the same shares of OSDs (orange line). The peak defers to February which registers about one third of all OSDs per season. Within the 2050s seasons, the highest shares of OSDs per month are in March and April, where the intraseasonal postponing of OSDs shares gets particularly obvious (red line).

This trend, which is also pointed out by analyses for the other ski areas in the investigation area, can be labeled “Christmas-Easter-Shift”, since the former seasonal focus around Christmas tends more and more towards Easter.

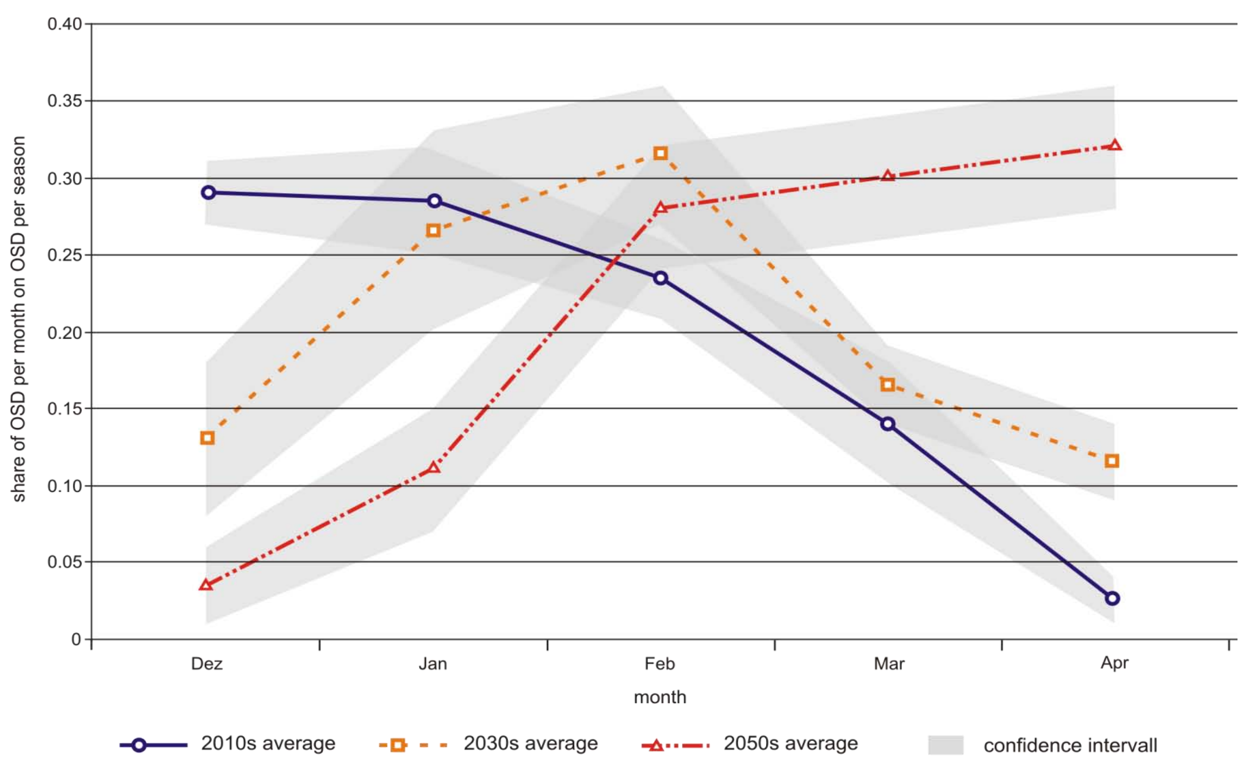

Figure 3: Monthly shares of OSDs per ski season for a ski area in Berchtesgadener Land, Bavaria, Germany: confidence intervals and averages of six different scenarios

4 CONCLUSION

The commonly used 100-day-rule implies a one-dimensional correlation of snow-reliability and profitability and does not allow for regional differentiation. The OSD provides more specified information than the sheer number of open days per season and thus helps, on the one hand, to sensitise tourism policy makers for the topic 'climate change impact', while on the other hand, the concept creates awareness of the importance of distinguishing between 'normal' open days and OSDs among ski area operators, tourism associations and hotels.

Our initial results illustrate that the absolute number of OSDs decreases over the simulation period in all ski areas while the spatial distribution remains relatively stable. Not only the number of OSDs per season, but also the general number of open days per season decreases over the simulation period in all administrative districts. Therefore, the temporal setting of OSDs is particularly important as it emphasises the increasing 'turnover seasonality', which for ski area operators implies that in the future, the necessary turnover has to be generated in fewer days and later in the season. The OSD can yield a decisive advantage to those actors who recognise at an early stage that, for example, new concepts or products have to be developed for Christmas time. Besides, stakeholders can prepare themselves for tourists' changed destination images (Zhang et al, 2011) and assess different possible adaptation strategies in order to stay competitive in the light of a changing climate.

The model of OSD may help tourism suppliers to gain knowledge of climate change impacts and may constitute a crucial competitive advantage. However, there arises the question of whether the demand side is willing to follow the expected trend of a Christmas-Easter-Shift. From a perceptual point of view, which plays a major role in tourists' decision making (Gössling et al, 2012), skiing may not be suitable in late winter as the tourist might have the image of a white strip of artificial snow (Unbehaun et al, 2008) in a non-wintry surrounding in mind. In March or April, tourists might already be attuned to spring and be tired of winter.

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