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Research Note

Panel based assessment of snow management operations in French ski resorts

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ABSTRACT

The vulnerability of the ski industry to snow and meteorological conditions accounting for snow management has been addressed regarding past conditions or under climate change scenario in most of the major destinations for skiing activities including the U.S.A and Austria, although not in the French Alps yet. Such investigations require quantitative data on snow management practices in ski resorts. So far the only information available in France was aggregated at the national level and outdated. The present study aims to provide detailed information of relevance for impact studies accounting for snow management including snowmaking and grooming facilities (ratio of equipped ski slopes, snowguns types, water storage capacity) and practices (grooming frequency, snowguns positioning, required snow depth regarding the date) in French ski resorts with respect to their characteristics. We collected information from 55 French ski resorts through a survey we set up in Autumn 2014, covering a large range of ski resorts (geographical situation, size, altitude), consistently with the dispersion of the population of French ski resorts. The participant ski resorts represent about 50% of the French ski resorts total ski lifts infrastructures. This survey confirms that the snow conditions are a major priority for ski resorts operators to provide comfortable skiing conditions, to ski back down to the village or even to connect with neighbouring resorts. The required minimum snow depth is shared by most resorts, decreasing from 60 cm in February to 40 cm in April with a minimum 40 cm to maintain regardless the date. Snowmaking also appears as the major method to mitigate the dependency to natural snow conditions. Most resorts are equipped in 2015 with very similar facilities (about 35% of ski slopes equipped) even though they indicate contrasted prospects. The survey does not outline significant differences in terms of snow management practices with respect to the size or the location of the ski resorts. Using these results together with additional information suggests that the smaller, low to medium altitude resorts show lower adaptive capacity than larger, higher altitude resorts to face the natural variability and projected changes of the climate consistently with international data. This raises the interest for further investigations for the profiling of ski resorts regarding their geographical situation, management mode or target market, with probably significant influences on their willingness to develop snowmaking facilities.

Management implications: The present study highlights several points of interest for ski resorts stakeholders.

- Resorts operators share most priorities regarding snow management to ensure the spatial continuity of ski slopes (ski lifts operation) under the worst meteorological conditions and to promote the ski resort by differentiating with direct competitors. A particularly strong attention is paid to the French academic holidays.
- The required minimum snow depth depends more on the period of the season than on the size of the resort and triggers the production of machine made snow (35% of ski slopes covered for which the facilities maximum altitude is significantly correlated to the average altitude of resorts ski lifts, slope 1.1).
- The location of a ski resort may have a significant impact on its adaptive capacity with contrasted vulnerabilities to natural snow conditions (not only due to elevation differences) and potentially further implications (relationships with host communities, financial robustness), outlining strong inequalities between ski resorts to face the current variability and projected changes of the climate.
- The access to the water volumes to produce machine made snow is already inequal between resorts, most of them relying on water reservoirs which average capacity is equivalent to a 38–48 cm snow depth on equipped ski slopes. Any evolution of the need for additional snowmaking will require proportionally higher water supply, storage and related costs.

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1. Introduction

Ten out of the thirty greatest ski resorts in the world are located in the French Alps leading the French ski industry to be a top ranked destination for skiing activities along with Austria, U.S.A, Italy, Switzerland or Canada (Abegg et al., 2007; Vanat, 2014). Therefore, winter tourism is a major industry and plays a fundamental role in the economy of French mountain regions (Falk, 2014; Lecuret et al., 2014). In the Savoie Mont Blanc area,[1] 20% of the gross domestic product (GDP) of the departments is generated by the winter tourism (Lecuret et al., 2014). Skiing is the most practiced activity in winter (83% of visitors), far above the second (snowshoeing, 16% of visitors) leading the ski resorts operators to pay a great attention to skiing conditions and driving the corporation to an increasingly technical and professional snow management (Fauve et al., 2002; Lecuret et al., 2014).

Ski operators originally developed grooming methods in the U.S.A (Leich, 2001) to provide comfortable and safe skiing conditions (Bergstrom & Ekeland, 2004) and to maintain the resistance of the snowpack against mechanical erosion by skiers (Fauve et al., 2002; Guily, 1991) and the natural ablation processes (Keller et al., 2004; Rixen, Haeberli, & Stoeckli, 2004). Emile Allais first imported the method to France in the 1950's in Courchevel (French Alps) and as far as we know all ski resorts groom their ski slopes in 2015. Yet grooming can not compensate the possible deficit of natural snowfalls due to the interannual variability of meteorological and snow conditions (Beniston, 1997; Durand et al., 2009a). The consecutive seasons with poor snow conditions in the late 1980's in the european Alps (Durand et al., 2009b) revealed the vulnerability of ski resorts to the lack of natural snow and marked the kick-off for the development of snowmaking facilities in France (Spandre, François, Morin, & George-Marcelpoil, 2015). The competition with international destinations or alternative tourism activities (Morrison & Pickering, 2013) and the priority of specific periods (e.g. Christmas or February holidays) for the economic success of a season (Breiling & Charamza, 1999; Falk & Hagsten, 2016; Scott, McBoyle, Minogue, & Mills, 2006) encouraged ski resorts to mitigate their dependency to the meteorological and snow conditions through snowmaking facilities (Hopkins, 2015; Trawöger, 2014). Most resorts also rely on technological innovations to either adopt this strategy or produce snow in increasingly marginal conditions (Beniston, 2006; Hopkins & Maclean, 2014; Hopkins, 2015; Marke et al., 2014).

Concurrently with the snowmaking expansion, the economy of snow-related activities has been discussed in present time and under future potential climate conditions using several indicators such as the ski lifts tickets sales (Falk, 2014; Koenig & Abegg, 1997), the overnight stays of consumers in ski resorts (Falk, 2010; Töglhofer, Eigner, & Prettenthaler, 2011) or in terms of contribution to the gross domestic product (Damm, Koeberl, & Prettenthaler, 2014). A major challenge of researchers intending to assess the vulnerability of snow-related economy to climate change is to associate these indicators with climate dependent factors such as the mean snow depth (Falk, 2014), the number of days with snow on the ground (Töglhofer et al., 2011), with a minimum snow depth (François, Morin, Lafaysse, & George-Marcelpoil, 2014; Hanzer, Marke, & Strasser, 2014; Schmidt, Steiger, & Matzarakis, 2012; Scott, McBoyle, & Mills, 2003) or snow mass (Marke et al., 2014). Due to the difficulty to combine such transdisciplinary approaches (Strasser et al., 2014) and to compare the results from different combinations of indicators (Neuvonen et al., 2015), a standard definition of the snow reliability of ski resorts was established, combining snow depth and season length, the so-called “100 days” rule (Elsasser & Bürki, 2002; Scott et al., 2003). This was used to address the snow reliable altitude of a region (Abegg et al., 2007; Elsasser & Bürki, 2002), the decline of the ski season length due to climate change or the required amounts of machine made snow to compensate the loss (Scott et al., 2003; Steiger, 2010) even though the required snow depth may depend on the region (Pons-Pons et al., 2012; Scott & McBoyle, 2007) or on the period of the season (Damm et al., 2014; Hanzer et al., 2014; Hennessy et al., 2007). The adaptation of the ski industry to climate change through snowmaking has been studied in Australia (Hennessy et al., 2007), New-Zealand (Hendrikx & Hreinsson, 2012), Andorra (Pons-Pons et al., 2012), Spanish and French Pyrenees (Pons, López-Moreno, Rosas-Casals, & Jover, 2015), Germany (Pröbstl, 2006; Schmidt et al., 2012), Switzerland (Rixen et al., 2011), Austria (Damm et al., 2014; Steiger, 2010; Töglhofer et al., 2011), U.S.A. (Dawson & Scott, 2013) and Canada (Scott & McBoyle, 2007; Scott et al., 2003).

Surprisingly French and Italian Alps are major areas within the international skiing market where little investigation has been undertaken and has been limited to the analysis of past conditions and under natural snow conditions (Abegg et al., 2007; Elsasser & Bürki, 2002; François et al., 2014). Until recently there was no snowpack model able to handle snow production or grooming over the French Alps (Spandre et al., 2016) in addition to the prohibitive lack of information on snowmaking facilities in ski resorts (François et al., 2014). To the best of our knowledge there is no publication describing the French grooming facilities and practices, and the latest investigation on snowmaking facilities is limited to the ratio of equipped ski slopes with snowguns aggregated at the national level and based on data from the 2007 to 2008 winter season (Badré et al., 2009). Such limitations hampered any investigation, either in the past or under future climate projections, of snow conditions in French ski resorts accounting for snow management which require more detailed information on profesionnal practices (Hanzer et al., 2014; Scott & McBoyle, 2007; Spandre et al., 2016). The present study therefore aims to question the general priorities of French ski resorts operators and how these influence their habits and facilities in terms of snow management with respect to the existing international data (Abegg et al., 2007; Hennessy et al., 2007; Scott et al., 2003, Section 2). We also provide detailed information on the snowmaking and grooming facilities (ratio of equipped ski slopes, snowguns types, water storage capacity) and practices (grooming frequency, snowguns positioning, required snow depth regarding the date) in French ski resorts with respect to their characteristics (altitude, size and location).

Our analysis is based on a survey of a panel of 55 French ski resorts carried out in autumn 2014 and a specific database on French Alps ski resorts, allowing the analyze of the survey's results based on resorts features (Section 3). We identify the main priorities of ski resorts operators and the main drivers of the current practices and facilities in terms of grooming and snowmaking (Section 4), including their potential evolution until 2020. Last, we discuss the relationships between the vulnerability to natural snow conditions from François et al. (2014) of sample ski resorts and their current level of equipment in snowmaking facilities with respect to their main features, intending to provide a synthesis framework for the analysis of the development of snowmaking facilities within French ski resorts (Section 5). The limitations of the survey's setup and results are also discussed.

2. Literature review

2.1. Grooming impact and interest for stakeholders

The grooming of ski slopes is a fundamental method for the preparation of ski slopes shared by almost all resorts (Fauve et al., 2002). Grooming significantly affects the snowpack properties (De Jong et al., 2015; Fahey et al., 1999; Howard & Stull, 2014; Keddy, 1979; Keller et al., 2004; Mossner et al., 2013; Rixen et al., 2004). Fahey et al. (1999) monitored four groomed slopes and found that the average density was 36% higher on groomed slopes with respect to control slopes (ungroomed). Mossner et al. (2013) reported values

[1] French departments of Savoie (73) and Haute-Savoie (74).