Investigations on socio economic indicators of French Alps ski industry from an explicit spatial modelling of managed snow on ski slopes

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Investigations of the capacity of ski resorts to anticipate, cope with and recover from the impact of natural snow scarcity through snow management (grooming, snowmaking) have been realized in most of the major regions in terms of international ski offer although not in the French Alps hitherto. The present work therefore introduces an innovative approach for the investigation of socio economic implications of changes in snow conditions for the French Alps ski resorts based on a panel of 129 resorts representing 96% of the total French Alps ski lifts infrastructures. We integrated detailed spatial representations of ski resorts (including priority areas for snowmaking equipment) along with physically based snowpack modelling (including the physical impact of grooming and snowmaking). The viability of ski resorts was further adressed thanks to a commonly used rule based on the snow season duration at the village and ski lifts average elevations along with the development of original viability indicators of snow conditions in the French Alps ski resorts based on the specific periods for the economic success of winter sports: Christmas and February school holidays. Such indicators were correlated to the number of ski lifts tickets sales over the 2001 - 2014 period and proved to be relevant to investigate and predict the evolutions of ski lifts tickets sales under the current ski market conditions in the French Alps. Our results outlined the contrast of snow conditions between French Alps ski resorts, even when accounting for snow management, particularly regarding the geographical location of resorts (Southern versus Northern Alps), the size and related elevation range of ski resorts. Our physically based approach also allowed to compute the water and energy requirements for the production of Machine Made snow since the start of the development of snowguns in the French Alps. Our computations proved to be strongly correlated to the observed amounts of water from the existing literature and confirmed that the increasing surface equipped with snowmaking facilities in the French Alps is the major factor for the increasing water and energy requirements since 1985. Such approach therefore provides objective information on the impact of snow conditions on the economic activity of winter sports in the French Alps under past and present conditions and may be considered as a relevant approach for further investigations, including the impact of climate change on the winter tourism in the French Alps.