

Skiing over Christmas holidays no longer guaranteed—even with snow guns

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Technical snowmaking on the Gemsstock, Switzerland. Credit: Valentin Luthiger

For many people, holidays in the snow are as much a part of the end of the year as Christmas trees and fireworks. As global warming progresses, however, white slopes are becoming increasingly rare. Researchers at the

University of Basel have calculated how well one of Switzerland's largest ski resorts will remain snow reliable with technical snowmaking by the year 2100, and how much water this snow will consume.

The future for ski sports in Switzerland looks anything but rosy—or rather white. Current climate models predict that there will be more precipitation in winter in the coming decades, but that it will fall as rain instead of [snow](#). Despite this, one investor recently spent several million Swiss francs on expanding the Andermatt-Sedrun-Disentis ski resort. A short-sighted decision they will regret in future?

A research team led by Dr. Erika Hiltbrunner from the Department of Environmental Sciences at the University of Basel has now calculated the extent to which this ski resort can maintain its economically important Christmas holidays and a ski season of at least 100 days with and without snowmaking.

The team collected data on the aspects of the slopes, where and when the snow is produced at the ski resort and with how much water. They then applied the latest [climate change](#) scenarios (CH2018) in combination with the SkiSim 2.0 simulation software for projections of snow conditions with and without technical snowmaking. The results of their investigations were recently published in the *International Journal of Biometeorology*.

No guarantee of a white Christmas

According to the results, the use of technical snow can indeed guarantee a 100-day ski season—in the higher parts of the ski resort (at 1,800 meters and above), at least. But business is likely to be tight during the Christmas holidays in coming decades, with the weather often not cold enough at this time and in the weeks before.

In the scenario with unabated greenhouse gas emissions, the Sedrun region in particular will no longer be able to offer guaranteed snow over Christmas in the longer term. New snow guns may alleviate the situation to a certain extent, say the researchers, but will not resolve the issue completely.

"Many people don't realize that you also need certain weather conditions for snowmaking," explains Hiltbrunner. "It must not be too warm or too humid, otherwise there will not be enough evaporation cooling for the sprayed water to freeze in the air and come down as snow."

Warm air absorbs more moisture and so, as winters become warmer, it also gets increasingly difficult or impossible to produce snow technically. In other words: "Here, the laws of physics set clear limits for snowmaking."



Technical snowmaking requires certain weather conditions. Credit: Erika Hiltbrunner, University of Basel

540 million liters

The skiing will still go on, however, because technical snowmaking at least enables resort operators to keep the higher ski runs open for 100 consecutive days—even up until the end of the century and with climate change continuing unabated. But there is a high price to be paid for this.

The researchers' calculations show that water consumption for snowmaking will increase significantly, by about 80% for the resort as a

whole. In an average winter toward the end of the century, consumption would thus amount to about 540 million liters of water, compared with 300 million liters today.

But this increase in water demand is still relatively moderate compared with other ski resorts, the researchers emphasize. Earlier studies had shown that water consumption for snowmaking in the Scuol ski resort, for example, would increase by a factor of 2.4 to 5, because the area covered with snow there will have to be largely expanded in order to guarantee snow reliability.

For their analysis, the researchers considered periods of 30 years. However, there are large annual fluctuations: In addition, [extreme events](#) are not depicted in the climate scenarios. In the winter of 2017 with low levels of snow, [water consumption](#) for snowmaking in one of the three sub-areas of Andermatt-Sedrun-Disentis tripled.

Conflicts over water use

Today, some of the water used for snowmaking in the largest sub-area of Andermatt-Sedrun-Disentis comes from the Oberalpsee. A maximum of 200 million liters may be withdrawn annually for this purpose. If climate change continues unabated, this source of water will last until the middle of the century, at which point new sources will have to be exploited.

"The Oberalpsee is also used to produce [hydroelectric power](#)," says Dr. Maria Vorkauf, lead author of the study, who now works at the Agroscope research station. "Here, we are likely to see a conflict between the water demands for the ski resort and those for hydropower generation."

At first, this ski resort may even benefit from climate change—if lower-lying and smaller ski resorts are obliged to close, tourists will move to

larger resorts at higher altitude, one of which is Andermatt-Sedrun-Disentis.

What is certain is that increased snowmaking will drive up costs and thus also the price of ski holidays. "Sooner or later, people with average incomes will simply no longer be able to afford them," says Hiltbrunner.

More information: Maria Vorkauf et al, Snowmaking in a warmer climate: an in-depth analysis of future water demands for the ski resort Andermatt-Sedrun-Disentis (Switzerland) in the twenty-first century, *International Journal of Biometeorology* (2022). [DOI: 10.1007/s00484-022-02394-z](https://doi.org/10.1007/s00484-022-02394-z)

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