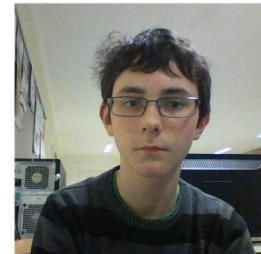


The Influence of Ski Tourism on Alpine Water Management and Possible Future Developments

Stefan Rietzinger, Vinzenz Moser, Julian Rothenbuchner
Sir Karl Popper Schule – Austria

Wiedner Gürtel 68, 1040 Wien
mschwarz@popperschule.at



1. Abstract

1.1 Water & Energy Consumption of Winter Tourism and its Consequences

If you think of Austria, what image pops up inside your head? Mozart, Salzburg, or Conchita Wurst? Most people would probably say skiing – which isn't far-fetched, considering that every year, an equivalent to a third of Austria's population visits the famous ski resorts. Therefore the winter tourism's revenue amounts to an astounding 14.3 billion dollars. However, the future of this important source of wealth is uncertain, since, due to climate change, the amount of snow that covers the mountain ranges is declining rapidly. To put this into perspective, the snow reliability is at risk in about 70% of all ski resorts.

In order to still enable skiing throughout the entire season, snow cannons are used more frequently every year, and to this day, these efforts have been mostly successful. But will the success continue while climate warming becomes more and more severe? Already, the water consumption of Europe's snow cannons is about 95 million cubic metres per year, while they munch away on electricity like a 150000 – inhabitant – city.

In the moment, the alpine ecosystem is able to sustain the strain, but as glaciers are shrinking and climate warming switches into overdrive, there are no doubts about the imminent water shortage that we are going to face. First symptoms are already noticeable in the French Alps, where the flow rate of mountain creeks have decreased by a whopping 70% and first conflicts about the water are developing. So, why are we continuing to waste energy and water for the enjoyment of others, in spite of the obviously bad side effects, and will the Alps be able to sustain the stress in the long term? These are some of the questions that we hope to find answers to.

2. Paper

2.1 On the purpose of the investigation

We aim at pointing out problems that are currently faced by ski resorts struggling to conserve both snow safety and the environment. And, as climate change takes ever bigger effect on the weather, forcing ski resorts to resort to sometimes desperate measures. However, the demand for well-prepared slopes that are open for longer being greater than ever before, the tourism industry is left with a dilemma, in which it is they have to keep the balance between snow safety and sustainability, profitability and massively increased cost.

Furthermore, the goal of our work is to work out solutions to the imminent struggles of the ski industry, such as environmental destruction, mainly caused by increased water consumption, increased risk of floods and landslides due to the massive interference of the high quantity of naturally occurring water that is displaced from its original circulation, and the rising snow line, leading to an even higher demand of artificial snow. However, new technological achievements have given rise to and revolutionary technology that promises to resolve all the problems that are faced by today's tourism industry.

Finally, we are investigating the future of winter tourism under the aspect of sustainability and environmental impact. As water shortages have become a daily occurrence in some areas of the Alps, it has become obvious that the industry as a whole will have to strive for change. We shall also propose changes that both the industry and the customer should undergo in order to cope with the ever changing circumstances.

2.2 On the Utilized Methods of Investigation

To acquire information, we first concentrated on contacting scientists who are specialized on the topic as experiments in the area are costly and could not be conducted just by ourselves. We were lucky to get in contact with a wide variety of companies and institutes, including ski resorts, companies in the area of technical snow production, research institutes and universities. But, as it became

apparent that technical developments would not be able to guarantee a sustainable solution we came to the conclusion that the future very much lies in the hands of the behavior of the consumers.

Accordingly, we have resorted to conducting a survey in order to gather information on the opinion of the future customers, i.e. fellow students and pupils of lower age. People of all ages have taken part and have amassed to around 200 datasets, the results of which shall be presented later on.

As of yet, we are still striving to gain access to the laboratory and factory of NEUSCHNEE GmbH, which has gained the upper hand in the race for more sustainable technical snow.

2.3 On the Results of the Investigation

2.3.1 Issues

From our intense Collaboration with Institutes and Companies there has arisen a clear set of problems. The most pressing is the excessive water usage which is already having a dramatic effect on the sensitive alpine environment. Drastic declines as high as 70% in the flow rate of alpine creeks have already been measured, which is destroying numerous biotopes such as quagmires, moors and swamps. Furthermore it can lead to the destruction of spawning grounds of fish. Also, a lot of farmers are angered as their formerly rich grazing grounds are slowly drying out. In addition, because a lot of water is bound in the form of snow, spring brings along a whole barrage of dangers: Flashfloods, Lands- and Mudslides, Dam Breaches, and so on.

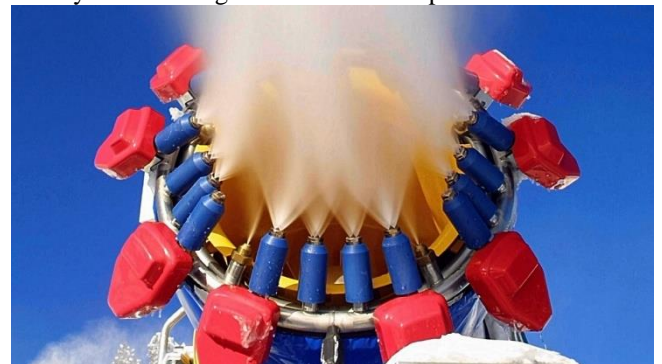
Another problem is caused by the fact that ski tourism and drinking water often utilize the same supply chain, which can lead to water shortages in winter. This has already happened several times in the course of the last several years, and, as the demand is ever increasing, this struggle for water will only intensify in the future. Some relief is promised by drainage pipes laid into the soil which is

supposed to relieve the stress on the drinking water system by tapping the rainwater. However, this only worsens the first issue mentioned.

Also, the increased weight of the snow layer because of the high density of artificial snow and the use of heavy machinery compresses the soil, reducing its permeability to the point of total incapability to absorb any water. As water just runs off instead of being absorbed the ground becomes more and more arid and is unable to sustain the rich vegetation that is needed to keep off erosion. Moreover, artificial snow often contains chemical additives to lower its melting point which cause harm to the sensitive alpine flora and fauna.

2.3.2 Solutions

Currently, the snow production is extremely wasteful, with over 60 percent of water being lost before it ever hits the snow cannons. A further 70 percent is lost in the snow making itself due to evaporation. New technologies aim mainly at increasing the maximum temperature at which



I A snow cannon that makes use of the traditional method

snow can be produced, using a lot of energy as they either use vacuum or cryogenic materials in combination with additives, both of which drive up the energy consumption dramatically. One technology, however, is aimed at increasing the efficiency both in terms of water and energy consumption by incasing the whole process within a plastic dome which does not let evaporating water escape. The technology can be compared to an “artificial cloud” because it is generating dendrites, hexagonal crystals which possess the classical snowflake shape compared to the

microscopic ice balls produced by current technology, which just sprays water into a stream of cold air.

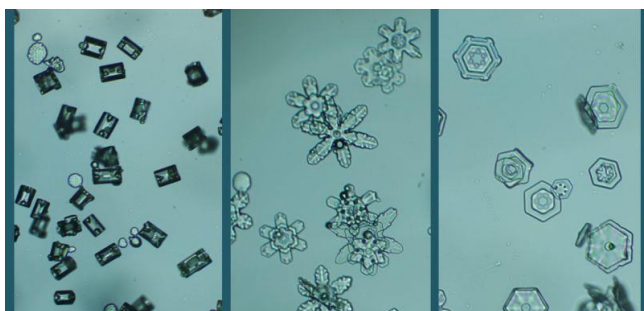
Because of this new technology, 15 m³ of snow can be produced from 1 m³ of water, which is more than seven times as much as is possible with current technology. We are still further investigating this technology and are confident that this technology is a way to resolve a lot of the problems faced by ski resorts.



2 Prototype of a snow cannon using the dendrite method

This new method of snowmaking also alleviates the problems caused by the high density of today's artificial snow as it results in lighter crystals, reducing the stress on the soil.

However, even all this new technology can't be the sole measure taken. Also, the tourists will have to adapt their behavior to the changing circumstances. Our survey has shown that most of them are wanting to ski from December to March, which will not be sustainable in the future. And, as only 20 percent are planning on giving up skiing, the number of skiers isn't going to decrease massively either. Most people were, as we found out, completely unaware of the problems caused by technical snow and the sheer water consumption.



3 Snow Crystals produced by current (left) and dendrite (middle, right) technology

In order to sustain both the thriving ski industry and the environment a compromise has to be found between maximum profit and a healthy environment. Ski resorts must always push for ever better technology while the customer must accept the fact that they must adapt to the changing climate by matching their habits. For example, the tourist could do a lot to ease the pressure by backing off his demand for a perfect slope all the way down to the valley. If the ski resorts weren't forced to keep the final slopes open, a lot of water and energy could be saved. Moreover, by educating themselves and raising awareness on the topic, consequently choosing ski resorts based on how responsible they are towards nature shall force them to invest even more in more sustainable technology.

In summary, we found that technology can offer some relief, but the problems can't be resolved without a change in touristic behavior. In order to tackle all the issues faced it is indispensable that both new technical developments such as dendrite technology and smarter management be utilized and tourists adapt their habits in order to lessen the impact on the environment by taking sustainability into account when booking a vacation and respecting the fact that it is often unwise to keep all slopes open at all costs. In addition, awareness must be risen of the excessive environmental damage done by the skiing industry.

2.4 Acknowledgements

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Picture 1:

<http://www.salzburg.com/nachrichten/salzburg/chronik/sn/artikel/sechsjaehriger-hollaender-prallte-in-filzmoos-gegen-schneekanone-178323/> accessed on the 14th of April 2016

Picture 2: <http://www.protectourwinters.at/aberschnee-is-ja-doch/> accessed on the 14th of April 2016

Picture 3: <http://neuschnee.co.at/Start.html> accessed on the 14th of April 2016

Links

<http://www.neuschnee.co.at/Schnee.html> accessed on the 15th of April 2016

<http://www.sciencev2.orf.at/stories/1749330/> accessed on the 15th of April 2016

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<https://www.youtube.com/watch?v=LxatvFPm3bg> accessed on the 15th of April 2016

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