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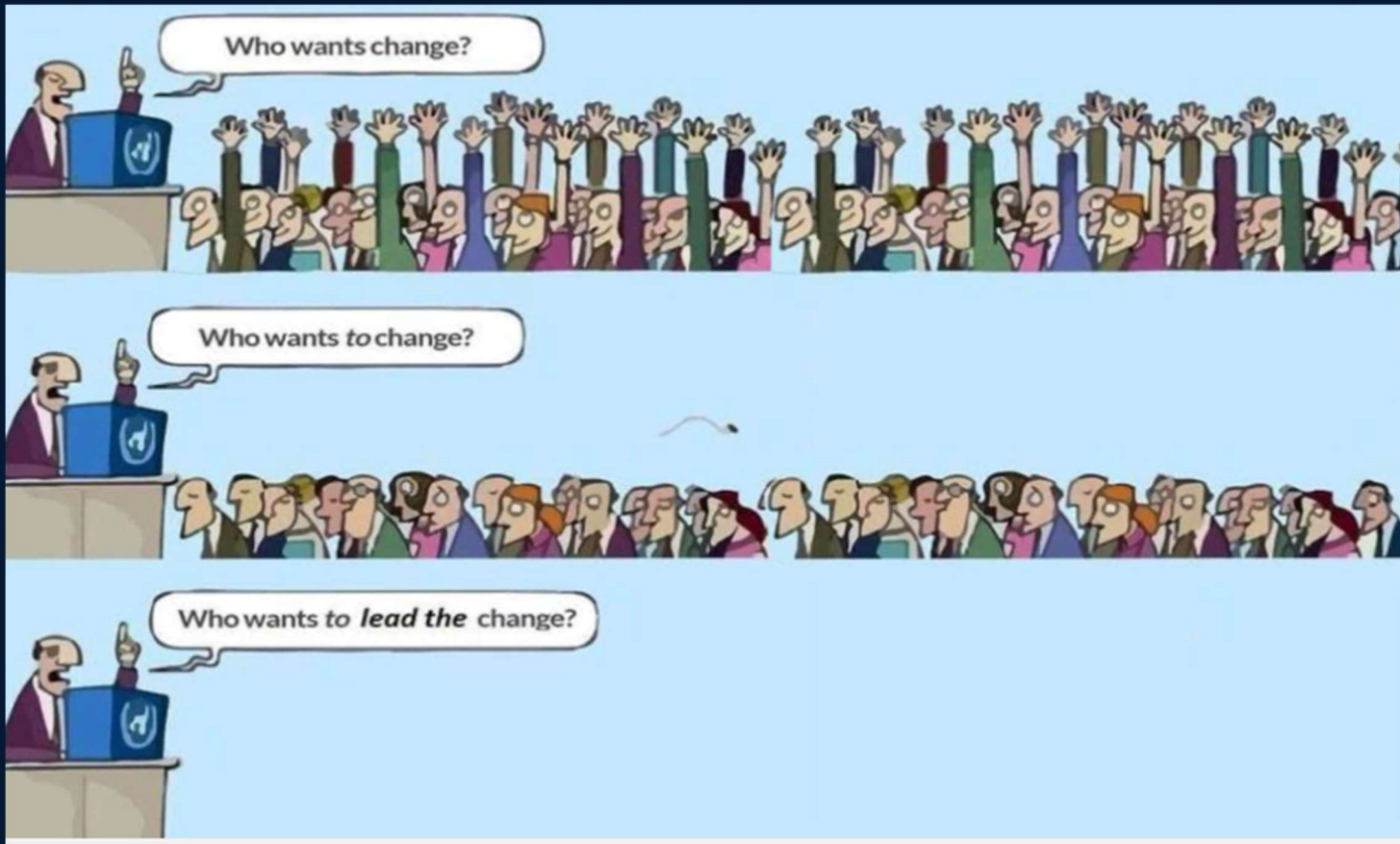
Bella Vista Institute of Higher Education

Switzerland (BVIS)

What is your perspective on change?



Who really wants change?



The laws of Physics set the limits

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

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Abstract

Rising air temperatures threaten the snow reliability of ski resorts. Most resorts rely on technical snowmaking to compensate lacking natural snow. But increased water consumption for snowmaking may cause conflicts with other sectors' water uses such as hydropower production or the hotel industry. We assessed the future snow reliability (likelihood of a continuous 100-day skiing season and of operable Christmas holidays) of the Swiss resort *Andermatt-Sedrun-Disentis* throughout the twenty-first century, where 65% of the area is currently equipped for snowmaking. Our projections are based on the most recent climate change scenarios for Switzerland (CH2018) and the model *StiSim 2.0* including a snowmaking module. Unabated greenhouse gas emissions (scenario RCP8.5) will cause a lack of natural snow at areas below 1800–2000 m a.s.l. by the mid-twenty-first century. Initially, this can be fully compensated by snowmaking, but by the end of the century, the results become more nuanced. While snowmaking can provide a continuous 100-day season throughout the twenty-first century, the economically important Christmas holidays are increasingly at risk under the high-emission scenario in the late twenty-first century. The overall high snow reliability of the resort comes at the cost of an increased water demand. The total water consumption of the resort will rise by 79% by the end of the century (2070–2099 compared to 1981–2010; scenario RCP8.5), implying that new water sources will have to be exploited. Future water management plans at the catchment level, embracing the stakeholders, could help to solve future claims for water in the region.

Keywords Climate change · Scenarios · Ski tourism · Snowmaking · Swiss Alps · Water consumption

Introduction

Winter tourism is an important economic sector in mountain regions. Globally, the European Alps are the number one destination for skiing, with 43% of all skier days worldwide. With 24.9 Mio registered skier days in 2018/19, Switzerland ranks as number six in the world (Vanat 2021). In the winter

season 2018/19, the Swiss cable cars yielded revenues of 758 Mio CHF (transport only; SBS 2019), underpinning the substantial economic value.

Rising temperatures due to ongoing and future climate change (Rebetz and Reinhard 2008; IPCC 2018) entail severe reductions in the snow cover (Mary 2008; Klein et al. 2016; NCCS 2018; Hock et al. 2019). For the Swiss Alps, winter and spring temperatures are projected to increase by 1.8 K by the end of the twenty-first century if we drastically reduce greenhouse gas emissions, or even up to 3.9 K without any abatement measures (high-emission scenario). Winter precipitation will progressively fall as rain instead of snow and may increase by 12%. However, the projections for the precipitation increase are less clear than for air temperature (NCCS 2018). Winter runoff will increase and the peak runoff will occur earlier because of earlier snowmelt (Haeblerl and Weingartner 2020). The operators of ski areas are thus confronted with major challenges for the future. The snow reliability of resorts has often been assessed by

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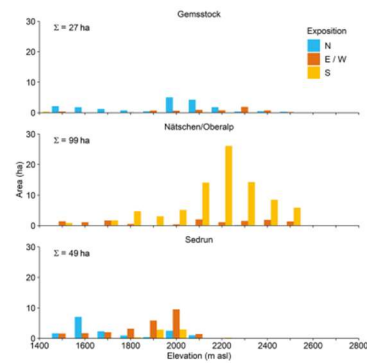
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Table 1 Snowmaking information for the three regions of *Andermatt-Sedrun-Disentis*, obtained from the operators

Region	Season	Area with snowmaking (% of total)	Water extraction	Usual start of snowmaking	Usual end of snowmaking	Pumping rates	Maximum wet bulb temperature
Gemstock	November–May	27 ha (53%)	Garsenhöbels (river)	Mid-October	January	60 L s ⁻¹	-1.5 °C
			Mulle (river)		January		100 L s ⁻¹
Nitschen/Obertal	Season: December–April	99 ha (80%)	Oberalpe (lake)	Mid-November	January	270 L s ⁻¹	-1.5 °C
Sedrun	December to April	49 ha (50%)	Mollinatsch (river)	November	January	25 L s ⁻¹	-2 °C
			Val Val (river)	November	January		50 L s ⁻¹

Fig. 2 The operative areas for snowmaking along the elevational bands and for the aspects north (N), east or west (E/W, together), and south (S) in the three skiing regions. Currently, around 65% of the skiing slopes can be technically snowed-in

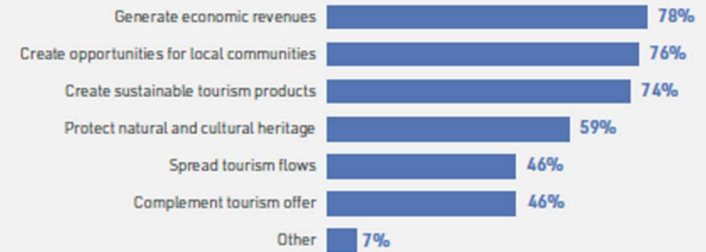


The laws of physics set clear limits for snowmaking. (Photo: Erika Hiltbrunner)

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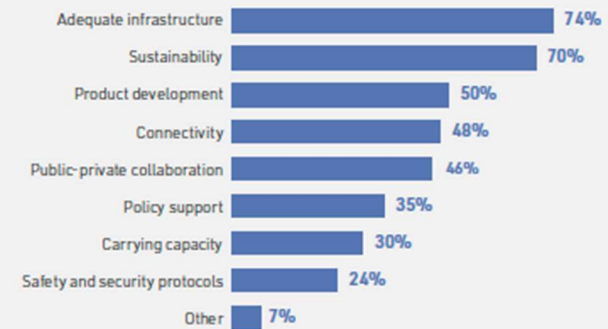


Figure 4.1: Main purposes of mountain tourism development for national tourism administrations (%)



Source: Responses from survey of UNWTO member states for the purpose of this study, n = 46.

Figure 4.2: Main challenges when developing and promoting mountain tourism for national tourism administrations (%)

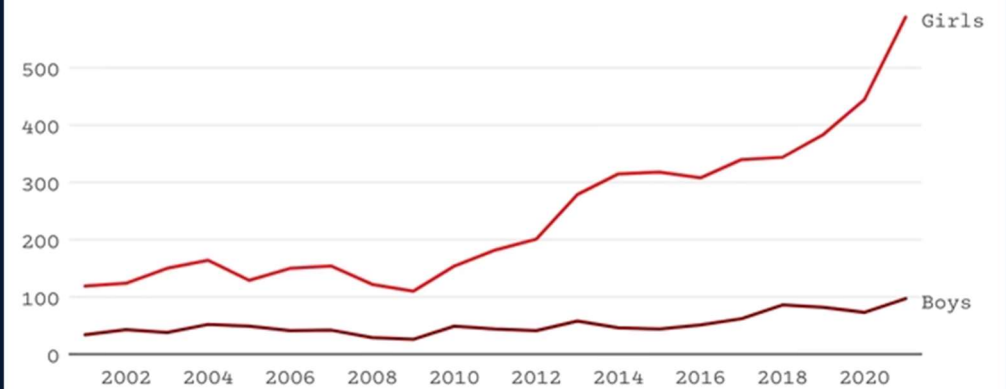


Source: Responses from survey of UNWTO member states for the purpose of this study, n = 46.

The Generation Challenge

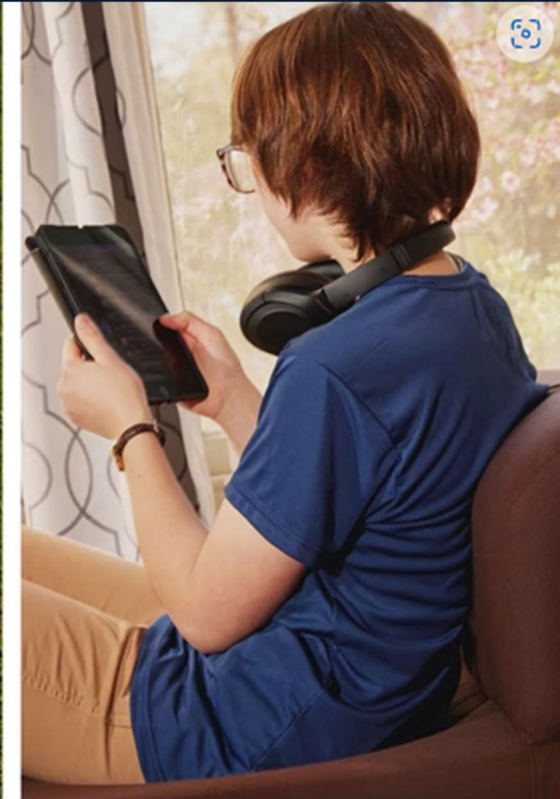


Self-Harm Rates of U.S. Children Ages 10–14



Number of emergency-department visits for nonfatal self-harm per 100,000 children (source: Centers for Disease Control and Prevention)

They can change then just need a reason



Let's talk a minutes about Tiny Gains



Sir Dave Brailsford



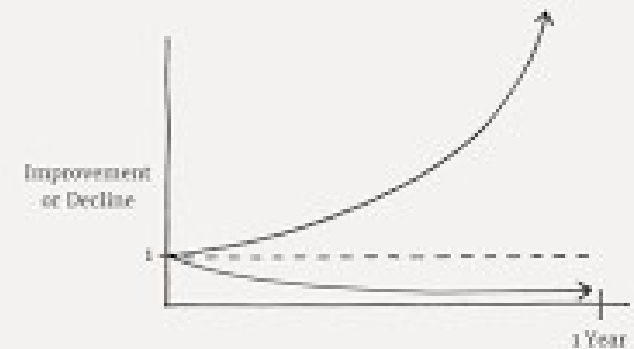
Marginal Gains

A method of reaching high-performance levels through constantly making small, incremental improvements.

Imagine what you could do with a culture on the 1% rule?

The Power of Tiny Gains

1% better every day $1.01^{365} = 37.78$
1% worse every day $0.99^{365} = 0.03$



JamesClear.com

Let us recap on what has been discussed

1. Perspective – Everyone will see a challenge differently
2. Change – “ We do want change”
3. 100 Day Snow – We agree we need to diversify, plan and re-strategize further
4. The Generations – Get them involved right at the beginning
“Education”
5. The Industries – Micro Education to solve the challenges
6. The Force of Community – Locals & Expats embrace change
7. Celebrate Everything – Celebrate the Milestones as a community especially with the youth
8. Wellbeing & Health – The Centre of every decision

The Right Stakeholders are in place



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Wishing Everyone
A Great Day!

Thank you!



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