

## Scenarios for adapting the high Alpine trail network to landscape modifications due to climate change

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### Abstract

The paper presents an approach to identify the need for action to adapt the high Alpine trail network to consequences of climate change. Landscape and tourism scenarios were developed for three sections of the Austrian Alps (Glocknergruppe, Venedigergruppe, Ötztaler Alpen). In five workshops these scenarios were discussed with regional stakeholders, who are concerned with summer mountain tourism in the study areas. Facing the ongoing glacier retreat and permafrost degradation, a change of the trail concepts as a whole might be necessary in some high Alpine regions.

### Keywords

mountain tourism, climate change, glacier retreat, mountain hazards, trail network

### Introduction and aims

The Alpine trail network is the infrastructural basis for summer mountain tourism (hiking, mountaineering) in a mountainous country such as Austria. Landscape modifications resulting from climate change (e.g. glacier retreat, permafrost degradation) affect the accessibility and usability of the trails and of the terrain in high mountain areas, often causing considerable risk for mountaineers (Fig. 1 and 2; see also BEHM et al. 2006; SCHWÖRER 2002). The quality of the trail network is a decisive factor for the safety and appeal of summer mountain tourism. Alpine associations work hard to tackle problems once they become acute. Preventive activities on a large scale are not possible since the Alpine associations do not have enough funds and voluntary workers available. The future situation of problematic areas cannot be modelled precisely. Nevertheless general strategic considerations are crucial to facilitate future planning and development of the high Alpine trail network.

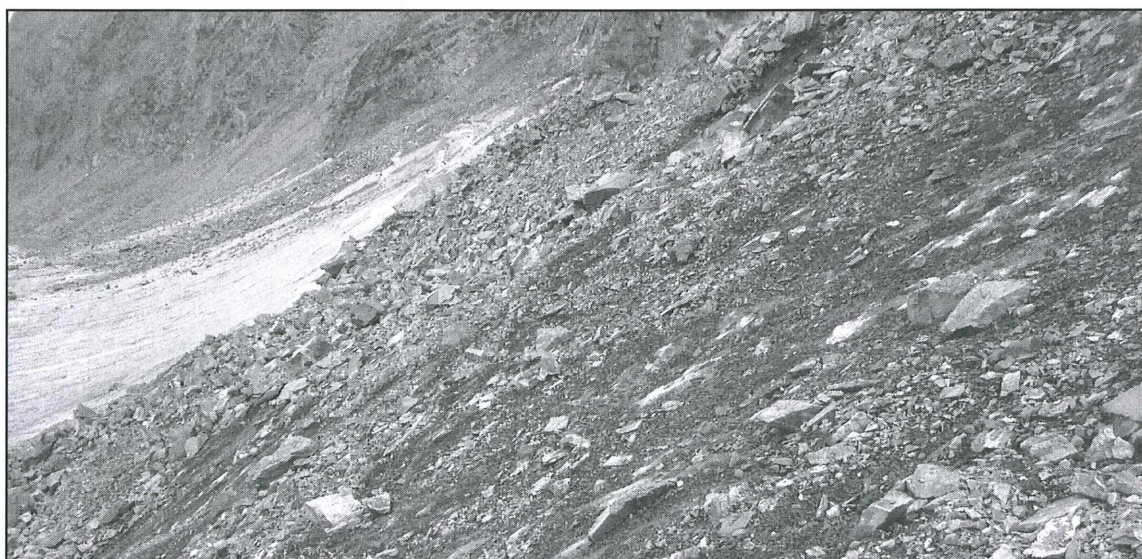


Figure 1: Due to debris-fall and glacier retreat a steep debris-covered ice slope has developed at the margin of a glacier. To reach the summit of Lisener Ferner Kogel mountaineers have to cross this dangerous terrain. Lisener Ferner, Stubaier Alpen (Photo: F. Braun)



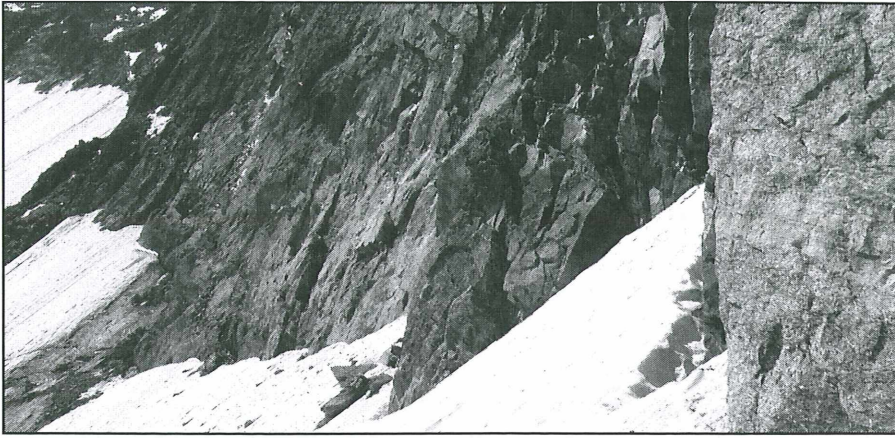


Figure 2: Along the route to Piz Buin a retreating glacier uncovered steep rock walls. Fixed ropes are now necessary to climb the route. Ten years ago mountaineers just went up on a snow slope. Wiesbadener Grätle, Silvretta (Photo: F. Braun)

Our approach follows the principles of transdisciplinary research with the goal of integrating scientific knowledge and the experiential knowledge of the case actors (BALSIGER 2004). The practical implementation is conducted in the three most heavily glaciated sections of the Austrian Alps: Glocknergruppe, Venedigergruppe and Ötztaler Alpen. In the context of this paper the term “high Alpine trail network” refers to the marked trail network as well as to frequently used routes across and around glaciers.

## Methods

To provide a foundation for the discussion with the stakeholders (e.g. Alpine Clubs, mountain guides, national park management, local tourist boards) we developed landscape scenarios, based on hiking maps (1: 25.000) of the three study areas. Using text boxes and special signatures the scenarios describe possible effects of landscape modifications on the trail network during the next 30 years (Fig. 3). The landscape scenarios are based on the knowledge of current effects on the trail network related to climate change, which have been collected by field mapping and expert interviews. Most of the analyses for developing the scenarios were realised in GIS-software. Main input data were digital elevation models, orthophotos and hiking maps. The expected glacier retreat and the permafrost distribution were both implemented by simplified empirical models.

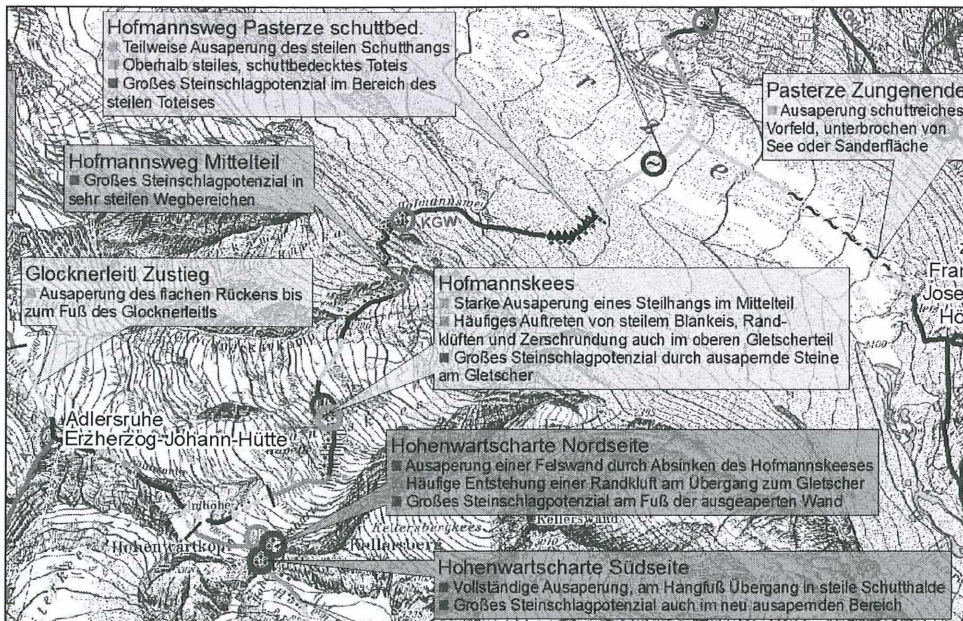


Figure 3: Detail of the scenario map in the surrounding of Großglockner (in German; Background: Alpine Club Hiking Map Glocknergruppe, 2006)

Complementary we developed three tourism scenarios, which are short narratives about the situation of summer mountain tourism in 2040, using a simplified system analysis and scenario planning approach according to SCHOLZ and TIETJE (2002). The tourism scenarios should provide a

discussion basis and confront the stakeholders with partly unusual ideas about possible developments of the high Alpine trail network:

In the first tourism scenario "Classical Mountaineering" the stakeholders try to maintain all existing high Alpine huts and trails. To handle the increasing effort all relevant stakeholders cooperate intensely concerning the management of the trail network. Nevertheless the quality of the trail network decreases in some areas due to problems related to glacier retreat and permafrost degradation.

The second scenario is named "Wellness-Hiking" and describes a situation where the stakeholders abandon problematic and little used high Alpine huts and trails. As a consequence, for most tourists some high Alpine areas become accessible only with special training or with guides. In return the Alpine clubs use their now available capacities to upgrade the hiking trail network and the huts in lower areas and at more suited sites.

In the third scenario "High Alpine Adventure" the stakeholders abandon problematic and little used huts and trails similar to the situation in the second scenario. In return suited sites are provided with infrastructure for adventure- and fun-activities. Problematic routes across glaciers are avoided by the construction of new via ferratas (fixed rope routes) leading to high Alpine summits along rock ridges.

## **Results and discussion**

The landscape scenarios show that the potential of routes for being affected by climate change varies considerably. Some routes seem to be very vulnerable, whereas others might not change heavily during the next decades. Of course the scenarios cannot model the detailed future development of single spots, but they are suited to transport a picture of the expected effects on the trail network in the study areas as a whole.

In five workshops the landscape and tourism scenarios were discussed with regional stakeholders representing organisations concerned with summer mountain tourism in the study areas. Most stakeholders evaluated the landscape scenarios either as being realistic or as underestimating the effects of climate change on the trail network until 2040. Discussing the tourism scenarios and the resulting need for action they concluded that an intensive cooperation of all relevant stakeholders will be essential for the solution of the upcoming problems. Facing the ongoing glacier retreat and permafrost degradation, the problems during the next decades cannot be solved just by continuing the current activities. A change of the trail concept as a whole might be necessary in some high Alpine regions. In this context both local and supra-regional needs and surrounding conditions have to be considered.

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