Warm and rainy summer as trigger for rock falls and debris flows in permafrost areas

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INTRODUCTION

Observations of recent years have shown that the frequency of natural hazards starting from permafrost areas has increased. These are usually processes that arise secondarily from permafrost regions, such as rockfall, landslides or debris flows. The effects of global warming and of summer precipitation events, such as heavy rain or long-lasting periods of rain, lead to a strong mobilization of debris in permafrost areas. Prone to this are in particular areas with rock glaciers and frozen screes.

STUDY AREA

Some well-documented events in South Tyrol in the years 2013 and 2014 have shown that mainly the combination of heavy rainfall with high temperatures has led to extraordinary events. Several fundamental starting scenarios can be distinguished:

- In two cases (Sulden-Valley and Schnals-Valley) debris and rocks broke away in great quantities from the forehead of an active rock glacier and were involved as sediment-provider significantly in the formation of debris flows.
- In two other cases, Ortler-massif (Trafoi) and Sella-massif (Dolomites) erupted a subterranean lake, at the same time a large debris flow reached some infrastructures near Trafoi. The outbreak occurred staggered some hours later than the precipitation event.
- Rockfalls from rock glaciers and rock walls fortunately don't apply to inhabited areas, but probably to a lot of hiking trails, walkways and accesses to huts in almost all high-mountain areas of Tyrol. Several times these ways were blocked or displaced because of prolonged rock falls (Sulden-Valley, Martell-Valley, Ahrntal, Sella-massif).

ANALYSIS OF EVENTS

The analysis of these events has shown that not only warm temperatures can trigger such events but that mainly the combination of high temperatures and precipitation events promotes the occurrence of such phenomena in the high mountains. One explanation for this must probably give the good thermal conductivity of water, because the „heat" is effectively induced into the ground only by the precipitation.

The measurement of the rock temperature (for example Grawand, Schnals-Valley and Ortler-massif) takes place in South Tyrol only since the end of 2009 and 2011 respectively, thus can not yet be clearly confirmed the actual impact of climate change on rock masses. An initial analysis has shown that mainly in the area between the rock surface and a depth of max. 15 m there are wide variations in temperature. This area is therefore called „active layer". Here the temperatures vary with different rhythms: day and night, seasonal, sometimes also within a few hours, for example, if a sudden change in weather occurs. The variations can account for up to 30°C between day and night. Inside the rock mass prevail constant negative temperatures of about -2.6°C at a rate of 3,200 m (Grawand) and -2.8°C at a rate of 3,800 m (Ortler).

CONCLUSIONS

While rock falls as a result of temperature fluctuations of the active zone are easily explainable and understandable, the movement processes in ice-filled fissures inside the rocky ridges are still largely unclear. The thickness of the active layer increases with the elevated temperature in the course of global warming. Accordingly also rockfall-events should be more frequent.

Figure 1. Debris flow channel below the rock glacier Similaungrube

Figure 2. Release zone from a rock glacier near Sulden (Ortler massif)

KEYWORDS

Permafrost; rock fall; debris flow; climate change

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