Submitted Abstract

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Abstract

Climate change may affect natural hazards in many ways such as through changing seasonal precipitation distribution or increasing frequency and magnitude of heavy rainfall events; however, all these changes are subject to uncertainty. What is beyond doubt, however, is that mean air temperatures are increasing. Therefore, we developed a tool that allows to quantify sediment availability in direct relation to increasing temperatures.

Factors, which are directly related to the potential effects of rising air temperatures on hillslides include:

The upward shift of the mountain permafrost boundary, i.e., the altitude above which the ground is continuously frozen, and, therefore, permafrost degradation.

Changes to the forest cover, for example, due to altered water balance, bark beetle outbreaks, wildfire or windthrow, and the associated reduction in the protective effect of the forest.

In this contribution we focus on permafrost degradation. The rise of the permafrost altitudinal boundary is strongly related to the rise of the average annual air temperature (about 150 m/ °C). The loss of permafrost may cause instabilities of rocks or loose material layers, resulting in a rising hazard potential for hillslides. Infrastructure in ski resorts, but also transport infrastructure and settlements at lower elevations could be affected.

In the project RECIPE (Reinforcing civil protection capabilities into multi-hazard risk assessment under climate change) we developed an approach to realize the assessment of the future hazard potential for hillslides based on available information regarding permafrost shifts. General steps are:

1) Determining the assumed shift of the permafrost boundary according to the increase in air temperature (IPCC scenarios)

2) Determination of unstable areas caused by permafrost degradation by merging a DEM with the Alpine Permafrost Index Map (APIM), which was generated for the entire Alpine region within the project PermaNET, showing the probability of the presence of permafrost. The high spatial resolution of the APIM (approx. 30 m) allows applications at the local level.

3) Determination of new release areas and process paths with runout-models

Conclusion

The approach was tested for examples in high alpine regions in Tyrol, Austria. Due to the temperature-induced upward shift of the permafrost boundary, high mountain areas above the current permafrost boundary will become increasingly unstable and thus contribute to more bedload and hillslide mass potential. A mass flow simulation from the additional release areas showed that significantly more infrastructure was affected by gravitational mass movements than in a simulation without considering the shift of the permafrost boundary.