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GIS-based modelling of rock/ice avalanches from Alpine permafrost areas

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Changing permafrost conditions caused by present (and past) atmospheric warming are likely to affect the stability of steep rock walls in high-mountain areas. The expected increase in periglacial rock fall both in terms of magnitude and frequency requires an improved awareness about related hazards. Additionally, rock-fall events in glacial environments may incorporate large volumes of ice and snow and show an increased travel distance of up to several kilometers. It is therefore of great importance for hazard assessments to model possibly affected areas and to forecast maximum distances that might be reached by rock fall material.

A GIS-based flow-routing approach is introduced for modelling rock/ice avalanches on a regional scale. Trajectories and affected areas are modelled by designating the path of steepest descent whilst allowing lateral spreading from the fall track up to 45°. The runout distances are determined using empirical models such as regressions based on avalanche volume and reach angle of larger events from the Alps as well as from other high mountain areas. Such empirically-based models are widely used due to their simplicity and robustness.

The model application to three major historical events in the European Alps shows the benefits for simulating rock/ice avalanches on a regional scale for first-order assessments. General flow pattern as well as changes in the direction of progession are reproduced in a realistic way and show that major rock/ice avalanches are predominantly controlled by topography as upslope movement cannot be modelled. The empirical model used for calculating runout distances suits well the case studies presented. Worst-case scenarios, however, may often overestimate real maximum runout distances in the European Alp, but is likely a good means to obtain conservative esti-

mates of potential maximum runout distances.