A criteria-set for the construction of a model cascade for fall-to-flow landslide chains

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Some of the most destructive landslide events in history have evolved through cascading effects where, for example, a rock fall in High Alpine areas transforms into a flow of rock, debris, ice, or snow. Amplification effects often result in high velocities and energies. As a result, such events can destroy private properties, infrastructure or can even lead to loss of life even in areas distant from the source.

In order to reduce the negative consequences of cascading landslide processes, numerical modelling can enrich the efficiency of risk management strategies. Unfortunately, most landslide run-out simulation models are designed either for fall or flow processes. However, it is presumed that, at least in some cases, cascading effects cannot be properly represented by only one single process model. Due to the complexity of combining and comparing models for fall and flow processes, not many attempts to do so have been documented.

In an attempt to fill this gap, the primary goal of this study is to define a criteria-set on how and when to couple the models, based on appropriate key parameters. Hence, we analyse computer models for fall and flow processes and evaluate whether their combination can provide an appropriate description of cascading landslides. A set of well-documented fall-flow events is back-calculated. Fall and flow are first simulated separately, with some overlap, each with a tool tailored for the corresponding process, based on detailed information on the case study. The input and output parameters for the overlapping areas are then analysed to investigate how and when process chains are linked. Thereby, one of the key challenges consists in the spatial transformation of the output of fall models to the input of flow models.

The findings will be used to develop a simulation framework allowing for the automated combination of fall and flow models in order to efficiently perform simulations which can be used as input for the design of hazard and risk management measures.