Automated delimitation of rockfall runout zones using high resolution trajectory modelling at regional scale

Luuk Dorren, Christine Moos, and Christoph Schaller

Bern University of Applied Sciences, HAFL, Zollikofen, Switzerland (luuk.dorren@bfh.ch)

More than ten years ago, Swiss-wide rockfall modelling was carried out to indicate potential hazard areas and rockfall protection forests within the framework of the SilvaProtect-CH project. The forest effect itself was not included in these models and only one block size ($1\ m^3$) was calculated. The aim of our study was to model rockfall runout zones using Rockyfor3D for block size scenarios ranging from $0.05 – 30\ m^3$ with explicit inclusion of the protective effect of the forest for an area of approx. $7200\ km^2$ in Switzerland and Liechtenstein with a 2m-resolution. For the determination of the start cells as well as the slope surface characteristics, we used the terrain morphometry derived from a 1m-resolution digital terrain model as well as the Swiss TLM geodata and information from geological maps. The forest structure was defined by individual trees with their coordinates, diameters and tree type (coniferous or deciduous). These were generated on the one hand from detected individual trees and on the other hand from statistical relationships between the detected trees, remote sensing-based forest structure type definitions and stem numbers from field inventory data. Based on the latter, we generated forest strata in addition to the detected individual trees. The delimited rockfall runout zones automatically derived from the simulated reach probability maps were validated with 1554 mapped historical rockfall events. The results of the more than 78 billion simulated trajectories showed that 94% of the mapped silent witnesses could be reproduced by the simulations and 78% were within the delimited runout zones. The median of the volume of the non-reproduced silent witnesses was $0.1\ m^3$, which led us to a hypothesis, that these mapped blocks could partly be deposited fragments from larger blocks. We conclude that a rockfall simulation with explicit consideration of the forest effect at 2m-resolution with plausible results is possible for very large areas.