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An evaluation of different flow models and varying DEM grid size for debris flows in the Swiss National Park

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In the Swiss National Park, debris flows are a frequent phenomenon. According to park regulations, man interventions are strongly restricted and the debris flow system is unconstrained, and therefore of special scientific interest. Debris flows have nevertheless repeatedly affected highways and hiking structures. In this study we first investigate the main characteristics and dimensions of current debris flows by field work and empirical parameterization schemes. This forms the basis for several debris flow modeling studies which were done with the objective to analyze (i) the effect of two different 2D-flow models, (ii) the influence of varyingly spaced digital elevations models (DEM) on modeling results, and (iii) the impact of potential future debris flow events. To this end, we evaluated a strongly topography-based GIS model (MSF) and a flow-routing model using the full dynamic momentum equations (FLO-2D), both predicting the area of inundation. Three generically different DEM's with grid spacing of 25 m, 4 m, 1 m were used in conjunction with the flow models. For most debris flow simulations, the resulting inundated areas predicted by the two flow models are in fairly good correspondence. The evaluation of the DEM grid spacing shows that for both flow models the 25 m DEM is not accurate for delineation of inundation areas for debris flows of the order of currently realistic and parameterized events (20,000 to 50,000 m3) but may be feasible for larger holocene events. 4 m and 1 m DEM's in conjunction with the MSF model mostly confine the simulated debris flow to existing channels and are in accordance with observations of recent debris flow events. FLO-2D shows numerical artefacts and extensive computation times when using the 1 m DEM. For the 4 m DEM, however, FLO-2D simulation results reveal the best trade-off and correspondence with field observations of break-out points in the flow channel or sediment deposit distribution on debris fans. The study shows that DEM

quality and grid resolution as well as the debris flow model applied are crucial for the resulting delineation of potentially affected areas, and thus for hazard assessment and mapping.