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Evaluating Voellmy resistance parameters for debris-flow simulation models

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Gravitationally-driven processes such as debris flows constitute a major risk in alpine regions. In order to avoid damages on infrastructure and settlements, the delineation of hazardous areas is required. For this, numerical simulation tools are often applied for use in engineering hazard assessment. For model calibration, information on past events provides a basis to estimate or constrain the essential input parameters. In this study we used two numerical simulation models for evaluating model friction parameters to best-fit runout lengths and deposition patterns of observed past debris-flow events on two alpine fans in Austria with flow deposit volumes of 10,000 m^3 and 25,000 m^3, respectively. The RAMMS-DF (RApid Mass MovementS - Debris Flow) runout model is based on a Voellmy-type relation to describe the flow friction, and the software DAN3D (Dynamic Analysis of Landslides) allows selecting different rheologies, including a Voellmy-type friction relation. All calculations were based on the same digital elevation model with a 1 m resolution and the same initial conditions. Our results show that both models are able to satisfactorily replicate observed deposition patterns. The best-fit parameter sets of the Voellmy-Coulomb friction coefficient and turbulent coefficient for both study sites and both simulation models were in the range of 0.07-0.11 and 200-400, respectively. In case the deposition area is forested, the Coulomb friction parameter was considerably increased by a factor of around 3 to account for additional surface roughness. A sensitivity analysis shows a slightly higher sensitivity of model parameters for the DAN3D model than for the RAMMS-DF model. This study contributes to the evaluation of realistic model parameters for the simulation of small alpine debris flows on forested and non-forested fans.