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Topographic uncertainty in mass flow simulations - preliminary results

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Landslides and associated mass flow hazards are a major threat to humankind, especially in times of climate change when global warming and continued urbanization will dramatically increase the associated risk. Depending on time and location of their occurrence, they can develop a massive destructive power. An intensive effort has led to the development of various simulation tools to quantify their impact, e.g. RAMMS or r.avaflow. On our way to further develop these tools into powerful instruments for decision makers, we have to consider the impact of uncertainty on the simulation model.

The aim of this project is to focus specifically on the impact of uncertainty of the underlying topography data, that is on structural uncertainty. Topographic data in the form of digital elevation models (DEMs) are key input to any type of gravity-driven mass flow simulation, as they determine its dynamic to leading order. Yet, DEMs also contain uncertainties depending on the underlying source of data, its acquisition as well as uncertainty generated through the applied preprocessing techniques. Up to now, these kinds of uncertainties are often not systematically accounted for in mass flow simulation studies.

In this contribution, we introduce a modular, non-intrusive Python based work flow that creates and utilizes probabilistic DEM samples in a Monte Carlo simulation and conducts statistical analysis of the simulation results. We furthermore describe how topographic uncertainty is translated into probabilistic DEM samples based on geostatistical interpolation methods.

In order to test our approach, we hypothesize the presence of a region of topographic uncertainty, and apply the workflow to both an idealized reference model, and to a shallow-flow based mass flow simulation. We find that even a localized uncertainty, e.g. around a channelized topographic feature, can have a significant effect on mass flows. We conclude with a discussion of our results.