MURDIS – A DEBRIS FLOW MODEL

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INTRODUCTION

Debris flows are among the most efficient mass transfer processes and correspondingly have a vast destructive power. Given this fact, it is crucial to detect conflict zones between anthropogenic use and debris flows. This is where MURDIS makes its contribution. This model allows for simulating the propagation of a debris flow by taking into account different scenarios (e.g. different volumes).

GOALS OF THE PROJECT

The project has aimed at meeting the following main needs:

- Practice-orientation: MURDIS should become a tool well-suited for use in practice. This requires that the model parameters are determinable in an effective manner.
- Different scenarios: MURDIS should be able to handle various scenarios (e.g. different event evolutions and volumes).
- Protection measures: MURDIS should allow for pointing out the effectiveness of planned protection measures (e.g. dams).

METHODOLOGY

Prior to the actual modeling, the user has to identify zones from where debris can be mobilized during an event (henceforth "erosion sites"). Those erosion sites have to be mapped in the field. Likewise, the amount of mobilizable debris has to be assessed during a field campaign. From a modeling point of view, the user-estimated amount of debris is mobilized as soon as the debris flow crosses the mapped erosion sites.

Model Concept MURDIS

The identification of potential points of overflow and the calculation of the mass balance between mobilized and deposited debris are the two main tasks of MURDIS. In order to identify the points of overflow, the peak discharge of the debris flow has to be predicted in a first step. The applied formula of Mizuyama et al. (1992) distinguishes between mudflows and granular debris flows and estimates the peak-discharge as a function of the amount of transported solids. Assuming a triangular hydrograph, the model calculates the minimal cross-section that is required by the debris flow to remain in the channel. If the channel capacity is too low, the corresponding amount of debris leaves the channel. Based thereupon, the propagation of the debris flow is further modeled. Within the latter process, the deposited amount of debris is calculated continuously and subtracted from the mobilized amount of debris. The spread of the debris flow is stopped as soon as the debris is completely deposited (Stüdi, 2007).

Calibration of MURDIS using data of documented events

Data originating from five well-documented debris flow events were used to test the model. Amongst others, orthophotos allowed for comparing the model outputs to the documented events. Based on those tests, the model parameters were eventually calibrated.
As shown in Fig. 1, the Rotlauibach-event of 2005 was reproduced well. Discrepancies between simulation and event are indicated by the numbers 1 and 2.

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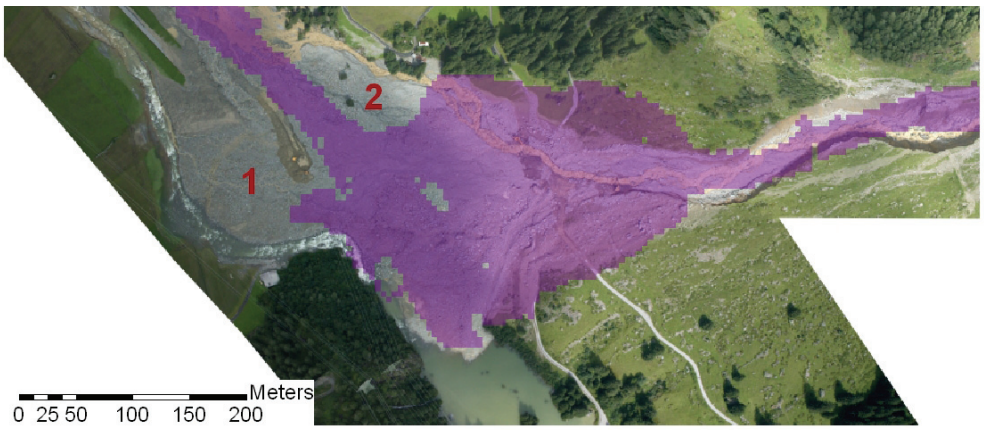

Fig. 1 Comparison between the model output (purple) and a 2005 debris flow event that mobilized ~500'000 m^3 of debris. Site: Rotlauibach near Guttannen, Switzerland. The numbers 1 and 2 indicate areas that were not reproduced by the model (Orthophoto: Flotron AG).

Application of the model

Meanwhile, the model has been applied on a number of occasions. Fig. 2 shows the result of the simulation in the catchment of Gurbsbach near Schwenden (Switzerland). In the illustrated case, a small debris flow (scenario 15'000 m^3) was modeled.

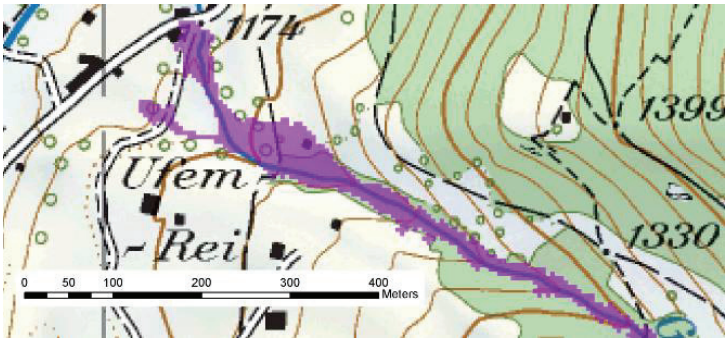

Fig. 2 Application of MURDIS to simulate a debris flow within the catchment of Gurbsbach (Schwenden, Switzerland). In 2005, a debris flow left the channel right at the simulated point of overflow (above „Ufem-Rei“) and damaged an adjacent building (Map: swisstopo).

CONCLUSIONS

The comparison of simulated debris flows to real events proved that MURDIS provides plausible results. The model allows for simulating various scenarios that can be used as a basis for risk assessments and the planning of protection measures.

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