COMPARISON OF 2-D DEBRIS FLOW SIMULATION MODELS

IMPLICATIONS FOR PRACTICAL MODEL APPLICATION TO HAZARD ASSESSMENT FOR ALPINE TRANSPORT INFRASTRUCTURE

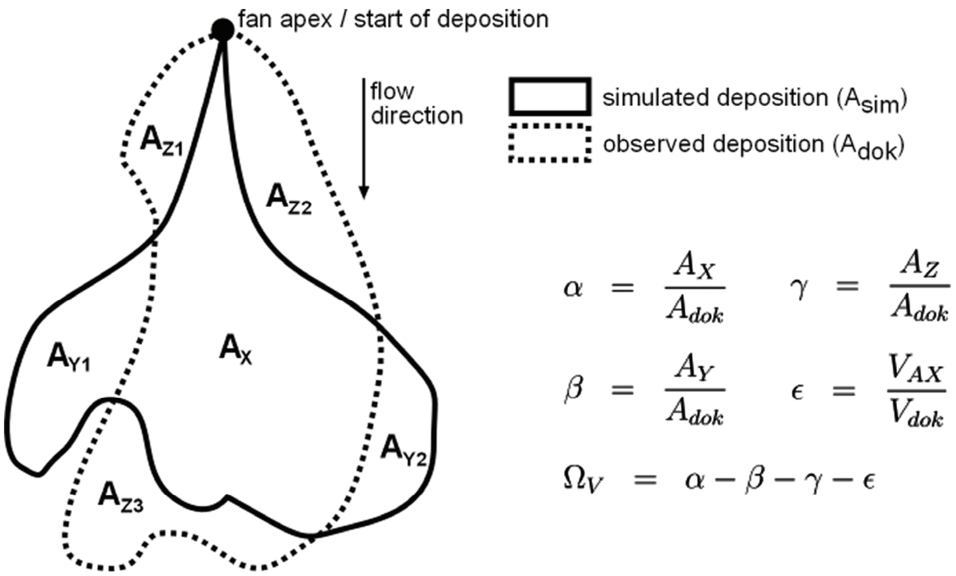
Andreas Huber[1]

INTRODUCTION

The destructive impact of debris flows does not only present a threat to human settlements on alpine debris fans but also causes severe damage to alpine transport infrastructure (roads, railroad) on a regular basis. For this reason it is important to identify potentially endangered road and railroad sections. Here simulation models can serve as tools for the prediction of depositional behaviour of the transported water sediment mixture. Over recent years a number of 2-dimensional models for debris flow simulation have been developed, however no single accepted, reliable and easy to use standard model for the delineation of potentially endangered areas seems to have been agreed on yet. Therefore the objective of the presented study is to give a comparative overview of a defined set of available 2-dimensional debris flow simulation models with special respect to the requirements emerging from hazard assessment for alpine transport infrastructure.

CONSIDERED MODELS

The considered models include FLO-2D (O'Brien et al., 1993), TopRunDF, TopFlowDF (Rickenmann and Scheidl, 2010) and RAMMS (WSL). While FLO-2D and RAMMS are dynamical models based on physical model approaches, TopRunDF is based on a semi-empirical approach combined with stochastic elements. TopFlowDF combines a simple physical approach with the flow algorithm implemented in TopRunDF.



$$\alpha = \frac{A_X}{A_{dok}} \qquad \gamma = \frac{A_Z}{A_{dok}}$$

$$\beta = \frac{A_Y}{A_{dok}} \qquad \epsilon = \frac{V_{AX}}{V_{dok}}$$

$$\Omega_V = \alpha - \beta - \gamma - \epsilon$$

Fig. 1 Quantitative evaluation of 2-dimensional debris-flow models after Carranza and Castro (2006). (adapted from: Rickenmann and Scheidl, 2010)

[1] Andreas Huber, BSc. - Federal Research and Training Centre for Forests, Natural Hazards and Landscape, Hauptstraße 7, A-1140 Wien, Austria (e-mail: andreas.huber@bfw.gv.at; a.huber1@gmx.at)

METHODOLOGY AND FIRST RESULTS

In a first step, the presented models were compared by a back calculation of five documented debris flow events in the alps based on topographical information obtained from Digital Terrain Models (DTM) of the respective catchments with a raster cell width of 2.5m. For the considered events the overall deposition volume and the planar extent and location of the deposition area are recorded. The depositional patterns obtained from the best-fit simulations were evaluated against the observed deposition of the documented events employing a method proposed by Carranza and Castro (2006) - also applied by Rickenmann and Scheidl (2010). The method is based on a simple intersection between documented and modelled spatial deposition patterns, thus identifying areas of conformity and discordance between the model results and observed deposition. Based on the identified sub areas A_{Xi} (matching areas between model and documentation) A_{Yi} (simulated deposition outside of observed deposition), A_{Zi} (observed deposition not covered by simulated deposition) and the modelled volume inside of the observed deposition, V_{AX}, an indicator Ω_V is computed. Under the precondition that the total observed area and the total simulated area are equal in size Ω_V takes values between -2 and 2 where a value of 2 indicates a very good conformity between modelled and observed deposition while a value of -2 indicates poor conformity.

Results for the comparison of observed depositional patterns with the respective best-fit simulations show that the modelled depositions are generally in reasonable alignment with the observed depositions.

This indicates that the considered models generally produce plausible results with regard to depositional behaviour on the fan if the input parameters can be calibrated according to documented events. However, for forward prediction of potential deposition zones the appropriate model choice and the sensible application of a model strongly depends on the quantity and quality of available information as well as on the purpose of the simulation results. Therefore, in a subsequent step, it is intended to further investigate how differences in availability of information used to define the input parameters affect the quality of simulation results for the compared models.

ACKNOWLEDGEMENTS

This study is conducted in the frame of the Alpine Space project PARAmount, which is part of the "European Territorial Cooperation" (Objective 3 of the Regional Policy 2007-2013) and is co-funded by the European Regional Development Fund.

REFERENCES

O'Brien, J.S., Julien, P.Y. and Fullerton, W.T., 1993. Two-dimensional water flood and mudflow simulation, Journal for Hydraulic Engineering Vol. 119 – 2: 244 – 261.

Carranza, E.J.M. and Castro, O.T., 2006. Predicting lahar inundation zones: Case study in West 32 Mount Pinatubo, Philippines. Natural Hazards Vol. 37 – 3: 331 – 372.

Rickenmann, D. and Scheidl, C., 2010. Modelle zur Abschätzung des Ablagerungsverhaltens von Murgängen. Wasser-Energie-Luft, 1: 17 – 26.

Adams M.S., Perzl F., Stehlik C., Schroemmer G., 2010. Improved accessibility: Reliability and security of Alpine transport infrastructure related to mountainous hazards in a changing climate – an introduction to the project PARAmount. Proceedings of the 'Mountain Risks' international conference, Firenze, Italy, 24-26 November 2010.

Keywords: debris-flow, 2-D simulation models, alpine transport infrastructure