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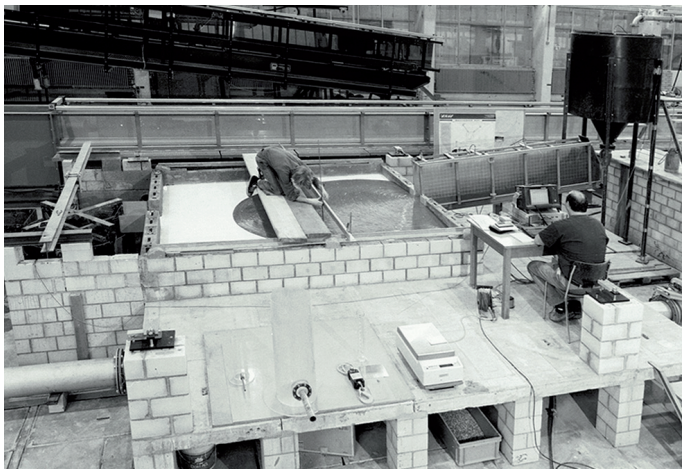
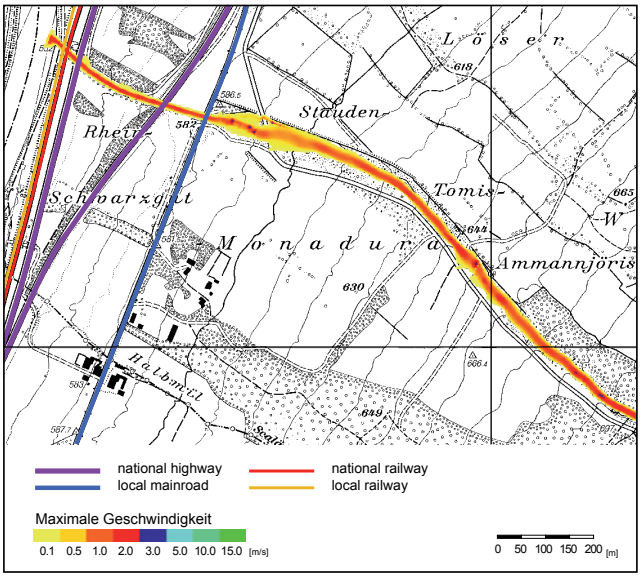
Physical and numerical modeling of debris flows

Deposition of viscous type debris flow in Fully in October 2000
Photo: Bundesamt für Wasser & Geologie.



Physical modeling: Experimental stand for the flow and deposition of model fluids.

In Switzerland there are several areas where debris flows occur regularly and numerous areas with a latent risk of debris flows. Following the scientifically predicted climate change, the number of the risk areas is said to increase in the future. In some of the areas the debris flows endanger villages and infrastructure such that practical solutions have to be presented. Possible solutions, such as sediment basins, channels, as well as the delineation of hazard zones are investigated with the help of physical or numerical modeling at the Laboratory of Hydraulics, Hydrology and Glaciology (VAW) of ETH Zürich.



Numerical modeling: Example of maximum velocities in the lower catchment area of the Maschänserrüfe after a large debris flow event of 150'000 m³ calculated with the code flo-2D.

Regarding physical modeling, similarity laws have been derived yet only for the flow and deposition process of viscous type debris flows. Once the band of the rheological material parameters of the prototype debris flows is known, the parameters of the model fluid can be determined based on the model scale and appropriate model fluids can be chosen.

As for numerical modeling, depending on the desired process (initiation, flow, deposition, segregation), debris flow type (granular, viscous) and topography/surface roughness a proper model has to be applied.

In the case of the simulation of the flow and deposition process of viscous type debris flow a numerical code which is based on a rheological model is applicable. At VAW the code flo-2D is presently used.

For both the physical and numerical modeling of viscous type debris flows one challenge consists in the determination of the rheological parameters of the prototype debris flow, expressing the internal physical material properties, say the shear rate – shear stress relation of the material. There are rough methods to estimate the parameters based on field observation of debris flows in motion and at rest, but there is a lack of more sophisticated rheometric techniques. In this context an interdisciplinary research project of VAW and the Institute of Food Science of ETH Zürich focuses on a new rheometric tool for the determination of the rheological behaviour of large particle material (see in Investigation of the rheological material properties of viscous debris flows).

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