

RAMMS – a Modeling System for Snow Avalanches, Debris Flows and Rockfalls based on IDL*

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Summary: Snow avalanches threaten villages, roads and railways in most mountainous regions in the world. Numerical simulation tools are required by engineers and land planners to predict avalanche runout distances and velocities in complex mountain terrain.

Zusammenfassung: *RAMMS – Ein Modellierungssystem für Lawinen, Murgänge und Steinschlag auf der Grundlage von IDL.* Lawinen bedrohen Ortschaften, Straßen und Eisenbahnlinien in den meisten Gebirgsregionen der Welt. Praktische Erfahrung und numerische Berechnungsmodelle sind erforderlich, damit Ingenieure und Landschaftsplaner Vorhersagen für Lawinen, ihren möglichen Verlauf und ihre Geschwindigkeit im Gebirge machen können.

The SLF is developing a unified software package RAMMS (Rapid Mass Movements) that combines three-dimensional process modules for snow avalanches, debris flows and rockfalls, together with a protect module (forest, dams, barriers) and a visualization module (GUI) in one tool. Because the system is linked with a GIS environment, RAMMS is a powerful, user-friendly tool for hazard mitigation studies in mountainous regions that are affected by gravity driven, rapid mass movements.

This report concentrates on the application of RAMMS in snow avalanche hazard mapping, which involves predicting flowing avalanche runout distances, impact pressures and flow velocities. The development of RAMMS started two years ago, using IDL's new Intelligent Tools, or iTools™. The pre-built tools, user interface controls and custom algorithms reduce our programming effort exceedingly and are integrated seamlessly. We made use of the iTools framework to build our completely customized graphical user interface, where we implemented iTools functionality, see Fig. 1.

Toolbar functions (printing, annotating, zooming, rotating, undo/redo, etc.), panels, status bar messaging, highlighting various parts of a surface using light objects and other useful tools from the iTools were implemented very easily. The visualization objects are defined as polygons, where maps, orthophotos and input parameters are mapped (as texture maps) on top. We use IDL to handle all the input and output specifications and visualizations. IDL's data ana-

* RAMMS – Rapid Mass Movements, ein Modellierungssystem für Lawinen, Murgänge und Steinschlag

WSL – Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft in Birmensdorf/Zürich

SLF – Eidgenössisches Institut für Schnee- und Lawinenforschung in Davos (ein Forschungsinstitut der WSL)

IDL – Interactive Data Language

GUI – Graphical User Interface, Visualisierungsmodul

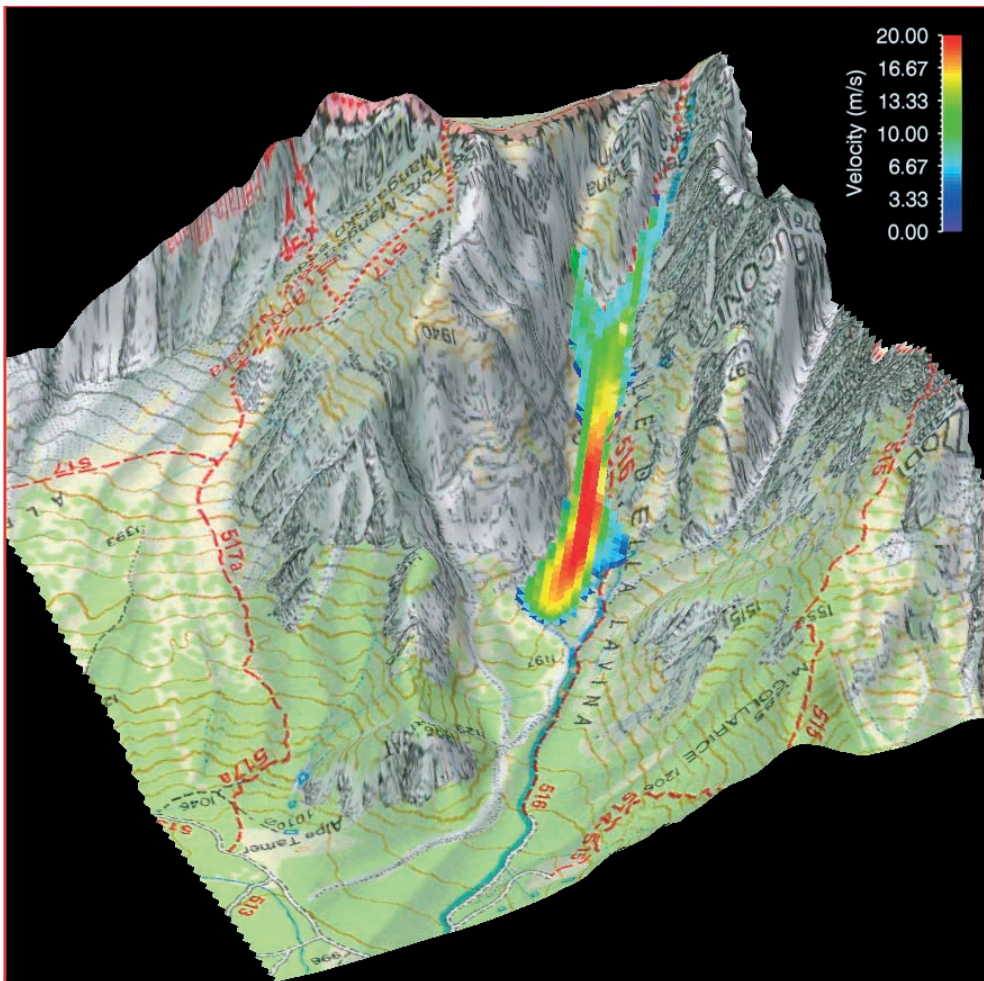


Fig. 1: The picture depicts the graphical user interface (GUI) of RAMMS. The simulation shows the position of a dense flow avalanche after 50 seconds. The avalanche flow velocity is stated in different colors, where red denotes flow velocities > 20 m/s and blue denotes small flow velocities. A georeferenced map is used as background for the topography (see cover page).

lysis ability is used to handle large DTM (digital terrain model) data sets. The DTM data (together with other input specifications) is then used to describe the depth-averaged motion of dense flowing avalanches in general three-dimensional terrain, employing a finite volume scheme that numerically solves the governing differential equations.

The numerical module is programmed in C which can be linked to the IDL interface.

The binary output results are then read, displayed and analysed with IDL, see Fig. 2.

The interactivity between different iTool types is a very important feature to analyse the output results in RAMMS. Line profiles and points can be drawn and displayed in an additional XY-Plot (iPlot).

Results can be exported as ESRI Shapefiles and compared in ArcGis with real data from our large scale avalanche test sites. ESRI Shapefiles can also be imported into

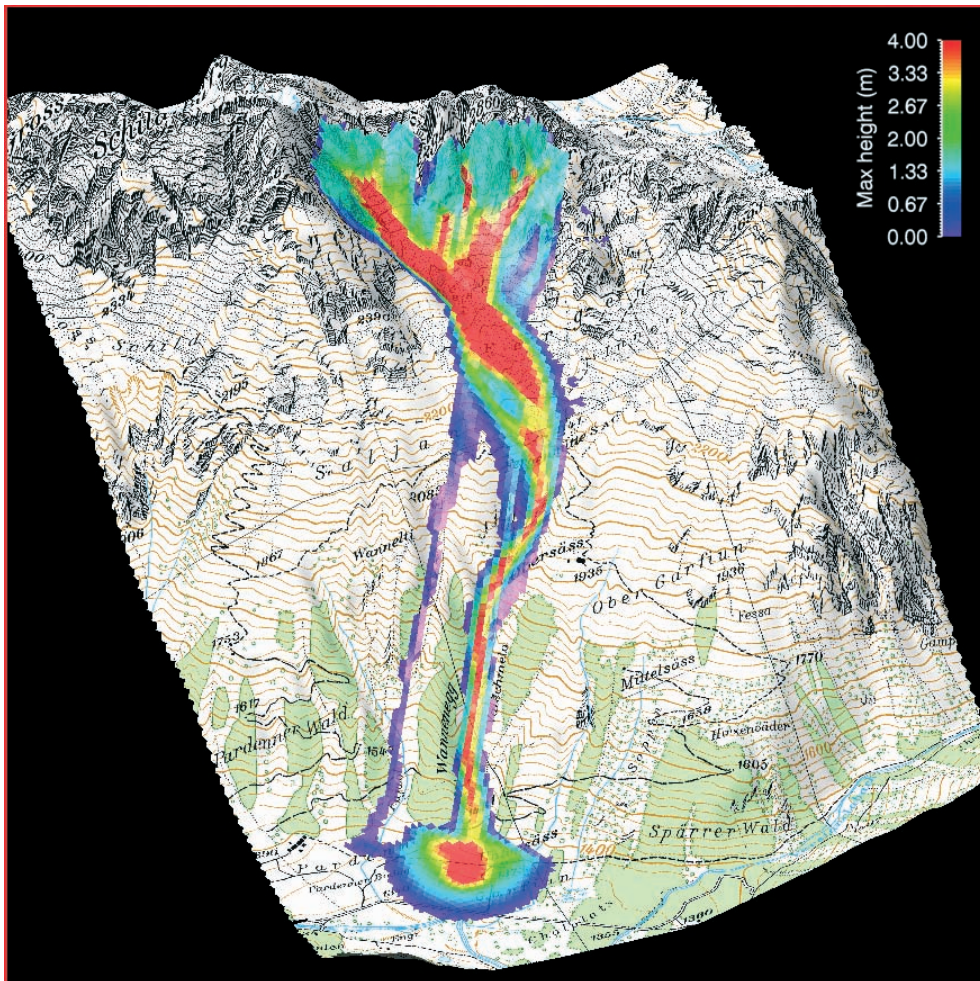


Fig. 2: This example shows the maximum flow height values from a dense flow avalanche simulation. The avalanche flow height is stated in different colors, where red denotes flow heights > 4 m and blue denotes small flow heights. A georeferenced map is used as background for the topography.

RAMMS. Additionally, GIF files, GIF animations and ASCII files can be exported and used in reports and web-sites.

RAMMS will be available to the natural hazard practitioners in the course of 2007. Thanks to IDL's Virtual Machine™, no additional licensing costs are necessary to distribute the software.

The new functionality of IDL's iTools™ is the perfect solution for our software package RAMMS, combining DTM data analy-

sis, visualizations, GIS and C interactivity and GUI user friendliness**.

References

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