



MODELLING AVALANCHES

SWISS SCIENTISTS HAVE DEVELOPED A MODELLING SYSTEM FOR SNOW AVALANCHES, DEBRIS FLOWS AND ROCKFALLS. THE RAPID MASS MOVEMENTS (RAMMS) SYSTEM LINKS GIS AND IMAGE ANALYSIS TOGETHER.

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.

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 pressure and flow velocities. The development of RAMMS started two years ago, using 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 implemented in the software functionality (Figure 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 visualizations 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

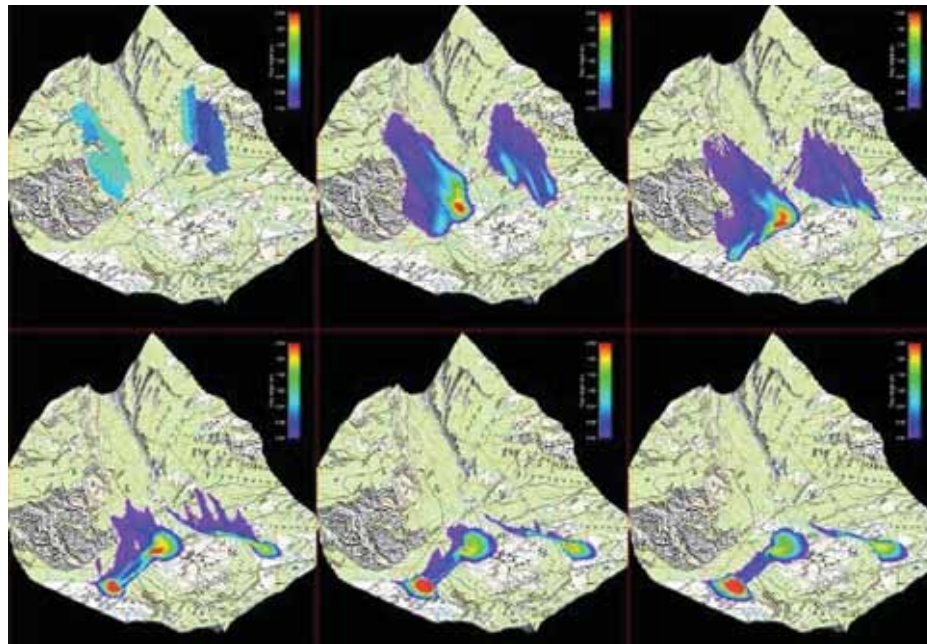


FIG. 1 - RAMMS graphical user interface (GUI), showing an avalanche site with automatically determined release areas (coloured).

input and output specifications and visualizations. IDL's data analysis 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 terrain, employing a TVD finite difference 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 (Figure 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 iPlot (Figure 3).

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 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 provides a solution for the software package RAMMS, combining DTM data analysis, visualizations, GIS and C interactivity and GUI user friendliness. CREASO's consulting services team was engaged in this project in form of two coaching sessions. The first took place during the design phase of this project and the second close before the finalization.

The SLF was founded in 1942 at Weissfluhjoch, Davos. Since 1989 it is part of the Swiss Federal Institute for Forest, Snow and Landscape Research WSL and is therefore a part of the ETH domain.

The main tasks of SLF are research, service and education around the subjects snow, natural hazards and the alpine ecology. Additional special fields of study include permafrost, snow climatology, snow sports and the integrated risk management. The broad variety of research areas requires a highly interdisciplinary research.

In addition to its basic research SLF offers a wide range of services as for example consulting assignments, expert evaluations on the causes of avalanches, and the development of warning systems. A primary (and well-known) duty of the institute is to publish the avalanche bulletin – the daily avalanche forecast for the Swiss Alps. The experts of SLF are active participants in education programmes at the ETH, at different universities in Switzerland and the abroad, as well as at many training and extension courses for avalanche professionals. SLF employs about 100 persons: scientific, technical and administrative staff, PhD- and undergraduate students. They come from all over the world, schooled in many different subjects, such as natural sciences, engineering, economics and social sciences. For more information about the research of SLF and WSL please visit the website at www.slf.ch

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More information: www.slf.ch and www.creaso.com

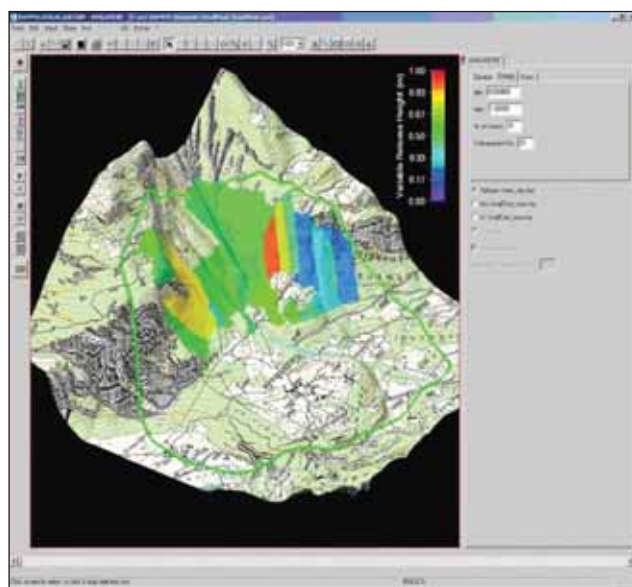


FIG. 2 - Simulation of two release areas. The flow height is displayed. Red areas indicate regions with flow heights > 2m.

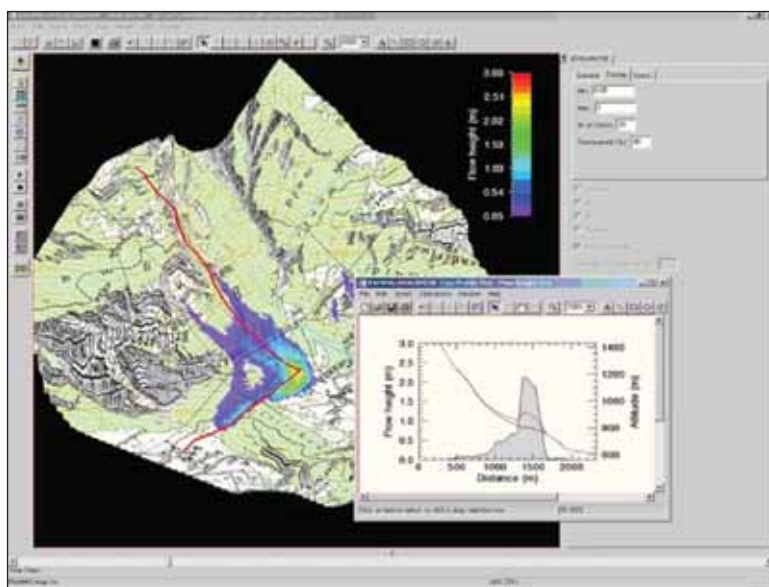


FIG. 3 - Line profile (red line within the topography) and corresponding iPlot, interactively connected to the GUI. Animation of avalanche will animate also the iPlot, change of min/max values of colorbar will change the left axis of the iPlot.