TREE-RING BASED RECONSTRUCTIONS OF PAST DEBRIS-FLOW EVENTS AND ASSESSMENT OF FUTURE RISKS IN 32 TORRENTS OF THE VALAIS ALPS (SWITZERLAND)

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INTRODUCTION

Debris flows represent a major threat in most mountainous regions, where their repeated and unexpected occurrence regularly causes fatalities, damage to infrastructure or the disrupture of transportation corridors. Detailed knowledge of past events, return periods, magnitudes, spatial patterns or triggers of past debris flows, therefore, is of crucial importance for the assessment of hazards and risks as well as for the design of structural and non-structural measures. This is primarily why a great deal of attention is commonly directed towards the analysis and documentation of processes in the aftermath of widespread flooding and debris-flow events.

Nonetheless, there generally exist only very few torrents and gullies that have been monitored over sufficiently long periods of the past. Similarly, archival records on former debris-flow events remain fragmentary and do not normally reflect a detailed history of former events. As a consequence, only little information is normally available on the characteristics or behavior of past events at basin scale, despite recognition that individual debris-flow events possess much greater erosive and hazard potential than flood processes.

Therefore, a big deal of attention has been paid to the understanding of debris-flow processes in many Alpine catchments over the last years. In several catchments of the Valais Alps (Switzerland), dendrogeomorphological techniques were applied to analyze and date past debris-flow activity with, at least, yearly precision. Dendrogeomorphology benefits from the fact that trees and shrubs growing in temperate climates form annual increment rings and that any kind of geomorphic disturbance (e.g., injury, stem burial or tilting, decapitation, erosion of root mass) remains recorded in the tree-ring series. In addition to the reconstruction of frequencies that may cover several centuries, it is sometimes even possible to approximate volumes that were transported during past debris-flow events. In addition, the analysis of the spatial distribution of trees that were disturbed during individual events in the past may also help the identification of preferential breakout locations of past debris-flow surges. The added knowledge that tree-ring analysis may furnish to magnitude-frequency relationships or the spatial patterns of past events may therefore help the identification of hazard zones for land use planning, risk assessments as well as for the design of appropriate structural mitigation measures. Finally, data obtained by means of dendrogeomorphological methods may also be used to feed or even improve modeling approaches at the basin-scale level.

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In a similar way, the high-resolution event series (i.e. monthly resolution) obtained in certain catchments further allow the coupling of event data with meteorological records of weather stations. Through the identification of weather regimes and meteorological conditions that have prevailed during past events, critical weather regimes or precipitation thresholds can be defined and used for early warning purposes.

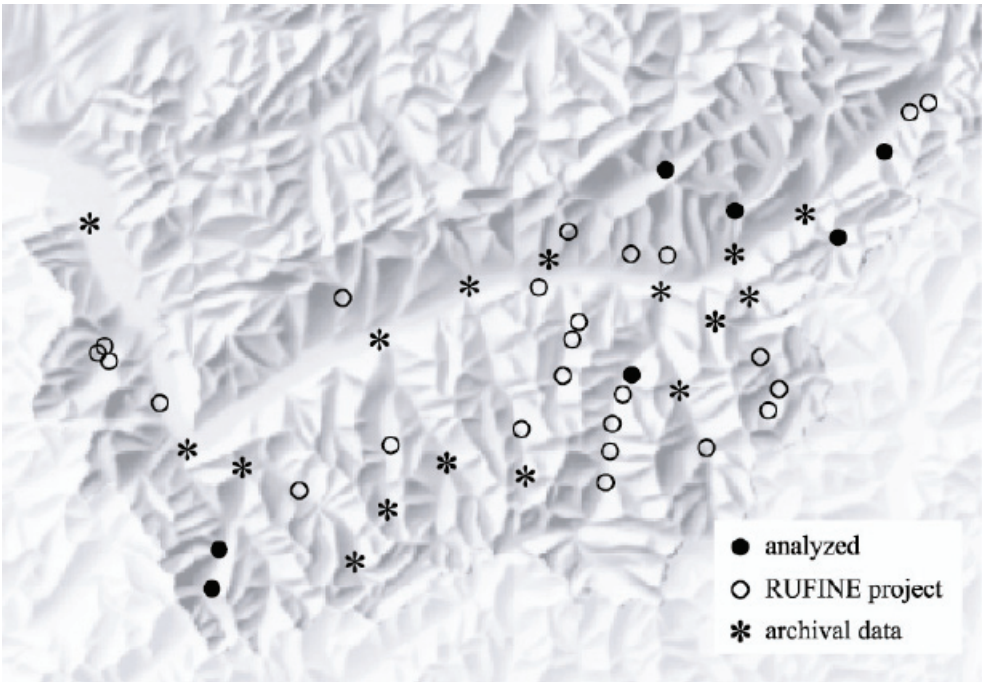

Fig. 1 Study sites of the RUFINE project (Valais Alps, Switzerland)

The Swiss Federal Office for the Environment (FOEN) as well as the Department of Traffic, Construction and Environment (Canton of Valais) have commissioned the Laboratory of Dendrogeomorphology at the University of Fribourg with the reconstruction and analysis of past debris-flow activity in 32 torrents and gullies of the Valais Alps over the next five years (2006–2011). The project is called „RUFINE " (i.e. the word used by the local population for debris flows) and its goals can be summarized as follows: (i) Where, when and how often did debris flows occur? (ii) How much material has been transported during past events and where has it been deposited? (iii) How did the frequency of events change in the past? (iv) What were the meteorological conditions (precipitation amounts, temperature) during past events? (v) Where can overbank sedimentation and the re-activation of abandoned channels be expected and where did such events occur in the past?

The RUFINE project was launched in fall 2006. Preliminary results from twelve debris-flow cones and gullies will be presented at the Interpraevent 2008 Conference.

Keywords: debris flows, tree rings, dendrogeomorphology, frequency, magnitude, climate change, Swiss Alps