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Geomorphological mapping in high mountain watersheds: the contribution of geomorphology to the evaluation of sediment transfer processes

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We will present the first results of a PhD thesis carried out at the Institute of Geography of Lausanne University (IGUL, under the supervision of Prof. Emmanuel Reynard) and with the collaboration of the Roads and Watercourse Service and the Forests and Landscape Service of the canton of Valais, Switzerland.

Introduction

A huge range of geomorphological legend systems have been developed since the sixties all over the world and currently, geomorphologic mapping is one of the main research interests of the Institute of Geography at the University of Lausanne (IGUL) that has developed its own legend, based on various European legend systems (Schoeneich et al. 1998). The legend represents landforms by their genesis more than by their dynamics and has been used in the Swiss Alps for twenty years. In fact, the IGUL legend is mostly used for inventories and the management of landforms or landscape protection and it is insufficient to appreciate dynamic processes like debris flows.

Problematic

After severe floods in Switzerland in 1987, the Swiss federal laws and ordinances on river engineering and forests impose the responsibility of establishing hydrological hazard maps, which should become an obligatory tool for land planning. The method applied by the federal authorities consists of three steps: the first one consists in establishing a "phenomena" map produced by using field geomorphological evidence (Kienholz, Krummenacher 1995) ; then, based on this evidence, intensity maps are produced, either by numerical modelling and/or expert-system mapping; the last step, called hazard map, is a much more synthetic map, which shows the different degrees of danger and is based on two main parameters: intensity and probability of hazard. The hazard map allows the representation of five degrees of danger.

This methodology is also used for snow avalanche and rockfall danger. The variety of tools available leads to some inconsistencies in the field. In fact, the recommended legend for mapping the phenomenon only gives a momentary vision of one single event. In theory, the phenomena map should be redrawn after each new event and all the maps should finally be superposed to have a global view of the flooded area. Indeed, experiences in debris flow mapping (Bonnet-Staub 2001; Bardou 2002) have shown that landforms related to theses fluvial phenomena are very active and may change very quickly over a short time and space scale. Fore example, some important characteristics of an event / torrential system are not considered, like the integration of past events / history of the stream, distinction between punctual and potential sediment alimentation of a debris flow, distinction of the different processes in the deposition zone or distinction of different deposition landforms.

There is, therefore, a need for more detailed information about volumes of potentially mobilised sediments, especially in densely populated mountain regions with a high potential of natural hazards. A better cartographic recognition of the slope system

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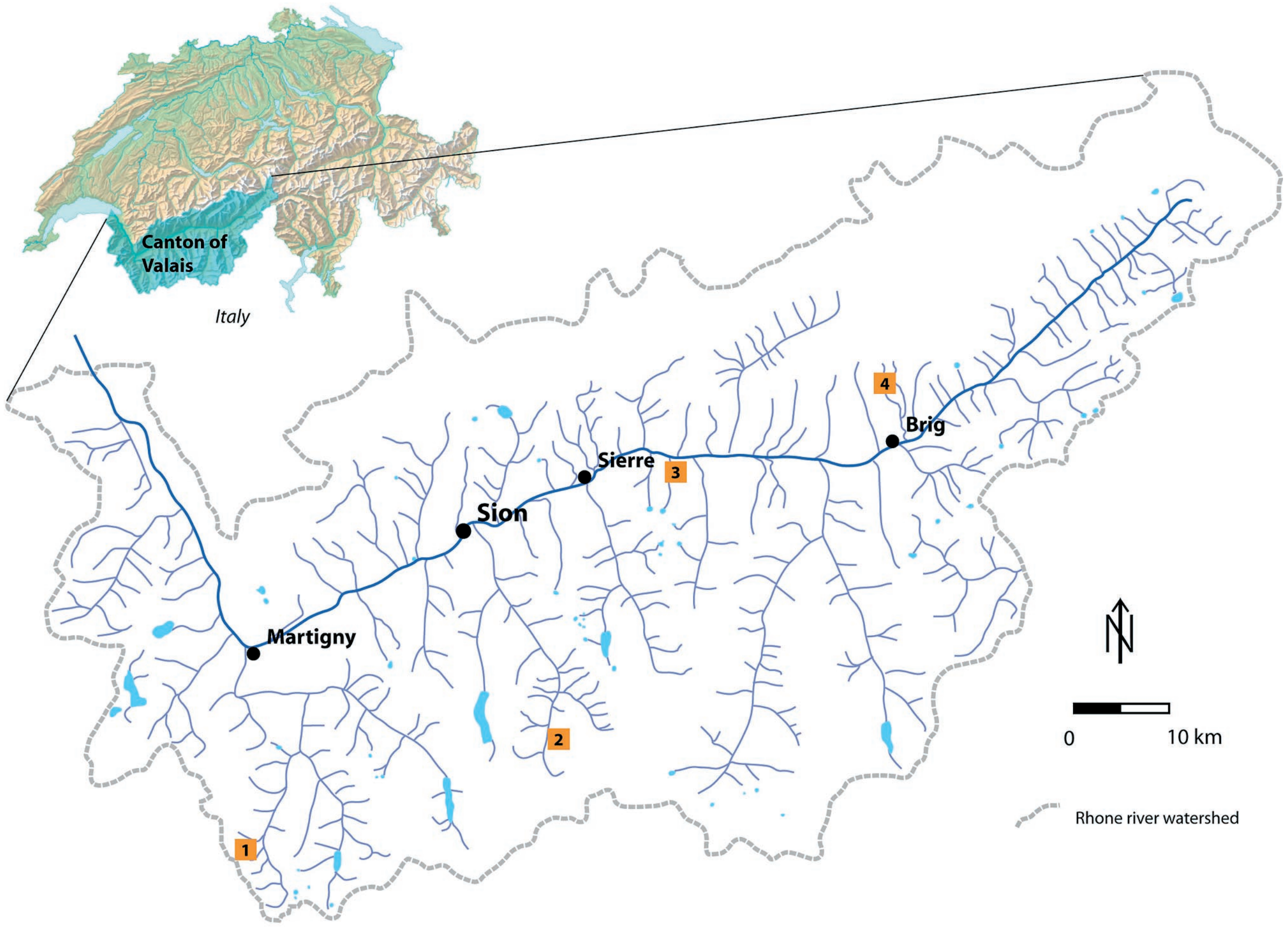

Fig. 1. Localization of the different study sites of the project within Rhone River watershed

and especially the sediment transfer processes, linked with a specific legend, could improve the knowledge on hydrological hazards in the studied area.

Project

Thus, since 2006, a new symbol-and-GIS based detailed geomorphological mapping system is in development. We have developed a conceptual geomorphic model, based on an "erosion system" from the top (rock escarpments, free faces in high altitude) downwards (alluvial fans, flood plain and scree cones, etc.). The aim is to consider the slope as a succession of connected reservoir subsystems varying in storage periods and emptying velocity. These reservoirs depict glacial processes and landforms (till accumulation, morainic bastions, etc.), periglacial processes (permafrost creeping, rock glaciers, solifluction, etc.), gravitational processes (landslides, rock falls, etc.), fluvial processes (debris flows, alluvial fans, etc.) and snow processes (snow avalanche deposits). This methodological approach may be used to quantify the postglacial sediment filling of alpine valleys (e.g. Schrott et al. 2003). The legend system should be able to consider all the factors governing sediment transfers, to produce susceptibility erosion maps and quantify the potential volume of sediment that may be mobilize.

Literature

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