Database shallow landslides and hillslope debris flows

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INTRODUCTION

Shallow landslides triggered by intensive rainfall are recurrent phenomena on steep slopes. Although their volumes are usually limited to several hundred m³, they pose considerable danger to humans and infrastructure because they often evolve into fast-moving hillslope debris flows with substantial runout distances (Fig. 1) and it is difficult to forecast their spatial and temporal occurrence. From 1972 to 2007, 32 fatalities and total damage costs estimated at 520 million Euros mostly from shallow landslides have been documented (Hilker et al. 2009). In 2005, a large devastating rainfall event in Switzerland caused more than 5000 shallow landslides during only three days (Bezzola and Hegg 2007).

Landslide inventories contribute to a better understanding of the processes and are important for hazard assessment and mitigation. This is the basis for a project, in collaboration with the Swiss Federal Office for the Environment FOEN, to compile a comprehensive database of all well-documented rainfall-triggered landslides and hillslope debris flows in Switzerland. It should enable statistical analysis of causative factors and, for example, testing of runout models. The database will be available for researchers and practitioners to support work to better understand the disposition of slopes to slide or flow processes, to support hazard assessment (e.g. hazard maps) and to design mitigation measures.

AVAILABLE DATA AND METHODS

In 1996 the Swiss national inventory StorMe (http://www.bafu.admin.ch/naturgefahren/11421/11426/index.html) was established, which aimed to support the documentation of hazard events in Switzerland, including landslides. Only basic information on the process is recorded, e.g. location, date and the damage which occurred. More comprehensive inventories, starting in 1998, with detailed information on numerous shallow landslides were made by the Swiss Federal Research Institute WSL after major rainfall events which triggered large numbers of landslides in watersheds of a few square kilometres in size (Table 1). These events were documented using analogue protocols, and covered many relevant parameters including the dimensions of the slides, and site characteristics such as vegetation, geomorphology, and topography, as well as characteristics of the subsequent runout (Rickli and Graf 2009). The new database includes information from the WSL landslides inventories and currently comprises more than 600 individual landslides. The database will be augmented following future storm events.

DEVELOPING THE NEW DATABASE

A first step in developing the new database comprised a reassessment and improvement of the field protocol and manual, made in collaboration with experts from governmental agencies and private offices involved in hazard mitigation. This involved the clarification issues including the selection of the required parameters as well as an assessment of the precision of the data. Based on this, a new database structure was developed using PostgreSQL software, and all available records (Table 1) were added. Photographs and sketches are included in the new database. In a second step, a user interface and long-term database maintenance plan were created. This application allows the import of new data and export of data for authorised users. A mobile device (e.g. tablet pc) version of the field protocol is planned to simplify the documentation of new events in the field, but several challenges related to data integrity remain.

The database enables the statistical evaluation of landslide data and is already being used for research projects (e.g. Hürlimann et al., 2015). The interface between the national event inventory

StorMe and the new database for shallow landslides and hillslope debris flows, presented here, is guaranteed using unique landslide identification numbers. In the case of future events with many shallow landslides, the FOEN and cantonal authorities will issue mandates to private companies or research institutions to collect data in areas with particularly large landslide densities.

Figure 1. Example of a hillslope debris flow originating from a shallow landslide near Flühli, Switzerland.

Table 1. Landslide-event inventories by the Swiss Federal Research Institute WSL at different locations in Switzerland. More than 60 parameters such as volume, inclination, and soil material were recorded per landslide.

Location	Date of event	Cumulative rainfall (mm), duration (h)	No. of landslides documented	Area of watershed (km²)
Sachseln	15.8.1997	150, 2	280	8.2
Appenzell	31.8.-1.9.2002	120, 9	107	10.2
Napf	15.-16.2002	60, 3	64	2.5
Surselva	14.-16.11.2002	252, 63	35	3.2
Entlebuch	18.-23.8.2005	269, 72	66	5.1
Prättigau	18.-23.8.2005	185, 72	63	4.7
Napf	18.-23.8.2005	241, 72	54	1.6
Eriz	4.7.2012	60-100, 2	25	9.5
Total			**659**	**45.0**

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KEYWORDS

shallow landslides; hillslope debris flows; database; landslide inventory; hazard mitigation.

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