FLOOD EVENTS AND SEDIMENT TRANSPORT DURING THE RAINSTORM OF AUGUST 2005 IN SWITZERLAND

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INTRODUCTION

During the period 21 to 23 August 2005 severe floods occurred in many torrents and mountain rivers along the northern side of the Alps in Switzerland. High flood discharges with intense sediment transfer processes were observed in particular in the catchments upstream of the large lakes at the foot of the mountain chain. In the plateau area between the Alps and the Jura mountains, the larger rivers carried substantial runoff with limited sediment transport but the flow overtopped at several locations. A lot of flood damages were observed particularly along all the streams which carried heavy sediment loads. The objective of this paper is to summarize the characteristics of the flood processes in the torrents and mountains streams and to present some preliminary quantitative analyses.

DOCUMENTATION

After the flood events of August 2005, an integral study was initiated by the Swiss Federal Office for Water and Geology (now Swiss Federal Office for the Environment) to document and analyse various aspects related to these events. The flood events were unusual in terms of their spatial extent covering large parts of Switzerland and in terms of the enormous damage costs of 3 billion Swiss Francs (Bezzola & Hegg, 2007). No similar events have occurred in Switzerland during the last decades. During the same rainstorm event, severe damaging floods also occurred in western Austria and southern Bavaria.

As a basis for the documentation and analysis of the flood processes along the stream channels, a summary data base was set up. This data base is intended to serve as a basis for an overview over the important sub-processes which occurred during the flood events, and for a more detailed analysis of selected phenomena which have not been observed or studied in sufficient detail before in Switzerland. In total almost one hundred single events have been registered. The basis for the compilation were summary reports compiled by the Cantons, special reports mandated by the Cantons for some of the larger events, technical reports prepared for new flood protection projects and the traditional StoreMe forms which are used in Switzerland for the documentation of hydrologically triggered natural hazard events.

CHARACTERISTICS OF THE 2005 FLOOD EVENTS

The spatial extent and the long duration of the rainfall were the reason that large and long-lasting discharges with intense sediment transport occurred in most rivers of the northern Alps. The most intense erosion, transport and deposition of sediments was observed in the

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areas with the most intense precipitation. The long surface and subsurface runoff duration resulted in a destabilization of lateral slopes and river banks, including substantial lateral erosion. Large amounts of sediment and woody debris were transferred through the stream network.

In the small torrent catchments many debris flows were observed, including medium to large sediment volumes; three debris flow events carried more than 100'000 m^3 of sediment. On many torrential fans, a substantial part of the sediment load was deposited; other torrents delivered important sediment volumes into the mountain rivers. In the affected regions, not all torrents showed exceptional peak discharges, possibly a result of the not extremely high rainfall intensities.

In the mountain rivers, relatively high discharges and large runoff volumes resulted in important erosion, accumulation, and sediment transfer processes involving large sediment volumes. In the headwater parts, sediment was partly supplied by the torrents. Overall, lateral erosion was found to be a dominant process which contributed also substantially to the sediment available for downstream transport. Along flatter stream reaches, deposition was an important process, reducing the flow conveyance capacity and enhancing flow overtopping and sediment deposition outside of the existing channels. At some locations bridges or weirs were obstructed by wooden debris and triggered the overtopping. At others the river changed its channel course. A typical damage pattern was the destruction of roads or railways along the river channel.

In the large valley rivers the discharge was often larger than the given channel conveyance capacity. In combination with the relatively flat flood plains next to the riverbed, large areas were inundated, resulting in substantial damage in inhabited areas or in industrial zones. Also along these river reaches, lateral erosion was an important process.

A further quantitative analysis of the data shows that there is a relation between sediment transport volumes and flood parameters, such as the flood runoff volume for a given catchment. This general relation is in qualitative agreement with simple sediment transport equations, and it is valid for the sediment volumes transported by either fluvial or debris-flood like processes in torrents. However, for steep channel slopes observed sediment volumes transported by fluvial processes are smaller than values predicted by traditional transport equations, clearly indicating a need for better prediction methods.

References:

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