MODELLING SEDIMENT TRANSPORT DURING A FLOOD EVENT IN A MOUNTAIN STREAM AND COMPARISON WITH LIDAR DATA

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INTRODUCTION

Modelling bedload transport in steep headwater channels/torrents is very challenging. For the calibration of a hydraulic model generally flow data are necessary, but in small catchments these data are mostly not available. The input hydrographs, necessary for the simulation model, need to be estimated with a rainfall runoff model and calibrated with reconstructed hydrographs. Flood marks at suitable cross-sections are used to back calculate the peak discharge. For the presented case study (Suggadin stream, Vorarlberg, Austria) of an extreme event that occurred in August 2005 one measured hydrograph for the upper part of the catchment is available and was used for the calibration of a rainfall-runoff model. In order to reconstruct the bedload transport during the extreme event airborn LiDAR data (Laserscans) were used to determine the morphologic changes. Two high resolution elevation models for the Suggadin stream catchment were available. The first was from the year 2002 and the second was obtained shortly after the extreme event. Areas of erosion and deposition were verified with aerial photos. For each channel reach the amount of sediment eroded or deposited was calculated. These data were completed with records from Sediment dredging after the flood. It is estimated that about 50 000 m³ of bedload were mobilized during the flood event of August 2005.
For torrents it is generally assumed that major morphologic changes occur only during flood events. During the considered time period no other major floods occurred in the catchment.

SEDIMENT TRANSPOR MODELS

Many sediment transport models for rivers are available, but most of them are limited to low gradient rivers. For torrents and mountain streams with steep slopes only a very limited number of simulation models exist (Papanicolaou et al. 2004). A one dimensional sediment transport model, valid for steep slopes, was applied to estimate the bedload transport that occurred during the extreme event in August 2005.

A one dimensional sediment routing model for steep torrent channel networks called SETRAC (Rickenmann et al. 2006) has been developed at University of Natural Resources and Applied Life Sciences, Vienna. SETRAC is the acronym for Sediment Transport Model in Alpine Catchments. Different sediment transport formulas (Rickenmann 1991, Smart & Jäggi 1983) and flow resistance approaches can be selected in SETRAC. Losses due to form roughness can be considered.

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SIMULATIONS

The model has been applied to estimate the bedload volumes that were mobilized during the extreme event. To take the uncertainty of the input hydrographs into account a scenario with moderate and one with maximum hydrographs, according to the variation of the peak discharge back calculated at different cross-sections, were modelled. The sediment volumes determined from the comparison with the LiDAR based elevation models serve as reference values. The sensitivity of certain input parameters, such as the input hydrographs and the influence of losses due to form roughness on the transported bedload volumes are discussed.

The aim of the paper is to discuss the model's capabilities and limitations to simulate bedload transport during an extreme event in a steep mountain streams. Furthermore the importance of the consideration of form roughness losses to describe erosion and sedimentation processes with a one dimensional bedload transport models is stressed, otherwise the transported bedload volumes are overestimated.

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