Discharge and bedload simulation using the example of the torrent Alperschonbach

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INTRODUCTION

The Alperschonbach is a torrent with a high bedload-transporting capacity in the municipality of Bach, Austria. For flood protection as well as ecological reasons, the Alperschonbach has been widened from the apex of its debris cone to its mouth to enlarge its cross sectional area and to achieve an interlocking of the torrent bank with its immediate surroundings. The channel should as a result be expanded so that redeposition may occur along its entire length. During the flooding event of 2005, massive sedimentation, up to 1.5 m in height, occurred in these widened reaches of the torrent. These gravel banks were only partly transported into the receiving stream Lech by smaller discharge events that occurred thereafter.

DESCRIPTION OF THE CATCHMENT AREA - STUDY SITE

The catchment of the Alperschonbach torrent is located in the district of Reutte in the northwest of Tyrol and discharges into the River Lech, in the municipality of Bach. With a catchment area of 83.8 km², it is the third largest southern tributary of the Lech River.
The HQ150 (design event) base value is 140 m³/s, which was derived under consideration of a variety of different scenarios for precipitation events. Sediment production in large parts of the catchment occurs from tectonic faults which traverse the catchment area, as well as from so called Kössener layers, which are very prone to produce landslides and debris flows in the upper parts. For the design event, a sediment volume of up to 50,000 m³ is therefore expected, which will be primarily deposited in the lower reaches of the channel and in the tributary Lech.

PROBLEM STATEMENT

For the new hazard zone map of the municipality of Bach an evaluation of the effects of a design event in this torrent and the receiving Lech was done. This evaluation included an analysis of the bedload-transporting capacity and an identification of sedimentation and erosion processes.
The evaluation of the bedload sediment budget is usually done by a section-wise approach of potential transportable bedload. In most cases the bedload sediment budget determined for a catchment area is shown in a bedload chart. This method usually applies only to a single catchment area without the influence of a tributary. For such drainage basins with a large widened river on the fan and the influence of a tributary, the limits of this section-wise approach are reached. In this present study an approach of combining different numerical bedload transport simulations (1D and 2D) will be presented and discussed.

METHODOLOGY

The terrain models were set up using terrestrial surveyed data of the channel and ALS data of the alluvial fan. Technical constructions, protection measures and buildings were integrated into the digital elevation models. Roughness parameters were derived by expert survey of the terrain.
The calculated scenarios ranged from short to long floodwave hydrographs. The sediment input was either set as variable percentage according to the hydrograph or as lateral sediment input from landslides. A variety of scenarios were also considered in terms of the receiving stream, the Lech as well as a set of different assumptions about possible bed erosion within the artificially widened sections of the channel.
The input data necessary for the bedload calculations were obtained by pebble count sampling on the surface layer as well as surveys to estimate sediment discharge and identify relevant torrent processes.

SPECIFIED SCENARIOS AND SIMULATION MODELS

Specified precipitation events, reflected in hydrographs which range from rather short 10 hours to 3 days, served as a basis for the scenarios used. For each precipitation scenario, the two types of sediment input were defined to subsequently be used in the model. In regards to the terrain morphology, the simulation was run both as the actual situation, with the currently existing gravel bars, and without these gravel bars in order to simulate the possible situation after a removal of these deposits. In additional scenarios, the receiving stream was also considered and modeled with a HQ10 discharge, in order to evaluate possible backwater effects. One scenario also included a partial log or driftwood jam of relevant bridges.

The described scenarios were modelled using the 1D model TomSED. The 2D- models FLO- 2D and HYDRO_GS-2D were used to describe where erosion and deposition occur and also to obtain information on the distribution of overland flows and flow velocities.

RESULTS

The results of the chosen scenarios provide a spectrum of results in regards to inundation height (water depth), bedload-transport (deposition and erosion), sheer stress at the bed and the effect of the receiving stream in the direct vicinity of the river mouth. Sedimentation of up to 1.5 m in the channel of the Alperschonbach leads to flooding of the banks along the foreshore. Backwater effects of the Lech exacerbate the situation in the immediate vicinity of the torrent's mouth. These results are in good agreement with the documentation of the 2005 flood event.

On the one hand the results were used to support the delineation of hazard zones and on the other hand as documentation material for public communication.

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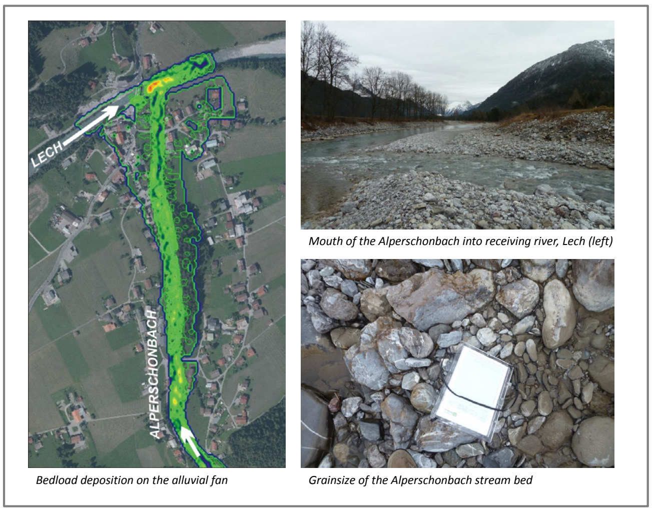

Figure 1. Alperschonbach: simulated bedload deposition (left) and situation at the torrent's mouth (right)

KEYWORDS

1- and 2-D bedload simulation; Hazard Zone Mapping

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