MONITORING AND CALCULATION OF BEDLOAD TRANSPORT AT THE MOUNTAIN TORRENT URSLAU

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Introduction

An integrative bedload monitoring system (Habersack et al., in prep.) was installed in 2010 at the downstream section of the Austrian mountain torrent Urslau by the University of Natural Resources and Life Sciences / Institute of Water management, Hydrology and Hydraulic Engineering, financed and supported by the Austrian Service for Torrent and Avalanche Control (Habersack et al., 2012; Kreisler et al., 2012).
This paper presents the bedload monitoring station, comprising direct (mobile bedload sampler, bedload trap) and indirect (geophone device) measurement methods. Moreover, it shows the monitoring results of four years and discusses existing approaches to calculate bedload transport rates using measured bedload transport data. Suggestions for an optimization of these approaches for a practicable use are presented.

Study Site

The Urslau torrent is located in the alpine region of the province Salzburg in Austria. It encompasses a drainage basin of 121.8 km² and is characterized by an average bed slope of 11.7%. The bedload monitoring station is situated near the town Maria Alm at the downstream section of the Urslau torrent. The drainage area upstream the measurement station is 56 km^2, bed width equals 8.2 m and the average bed slope near the station is 2%. The mean discharge at the gauging station Saalfelden (5 km downstream the measurement station) is 4.39 m^3s^{-1}.

Bedload Monitoring Methods

At the Urslau torrent seven geophone plates are distributed equally over the channel cross-section (Figure 1a). The geophone plates have a size of 15 mm x 360 mm x 500 mm. The geophone raw data signals are recorded and processed continuously. From these data, the following information is derived: impulses per minute, maximum amplitude per minute and the cumulative integrals of the signal. For special purposes it is possible to store values per second as well as the raw data signal itself. Thus, bedload data originating from geophone measurements provide permanent information about the quality and distribution of bedload transport within the channel cross-section in high spatial and temporal resolution. The required calibration of the geophone signal is performed by correlation with direct bedload transport measurements. At the Urslau torrent, these direct bedload measurements are conducted using a mobile basket sampler and a fixed bedload trap.
The concept of the basket sampler used is based on the mobile bedload sampler trap presented in Bunte and Abt (2003). It consists of a steel-frame, a sampler bag and a steel bar. The intake width is equal to 0.44 m x 0.26 m and the mesh size is 3.5 mm x 6.5 mm (Figure 1c). Bedload transport measurements are done with a mobile crane and the help of two tether lines, which are fixed on the sides of the steel frame and on both riverbanks, prohibiting the sampler to drift downstream.

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The bedload trap is mounted directly upstream the geophone device (Figure 1a). It contains a sample box (1.13 m^3, Figure 1b) which is placed on load cells. The trap is covered by a lid with a longitudinal sampling slot (1.6 m x 0.5 m). When starting with bedload sampling, the slot is opened hydraulically via manual control, allowing for bedload material to be trapped in the container. The load cells commence recording automatically the bedload mass increase within the trap.

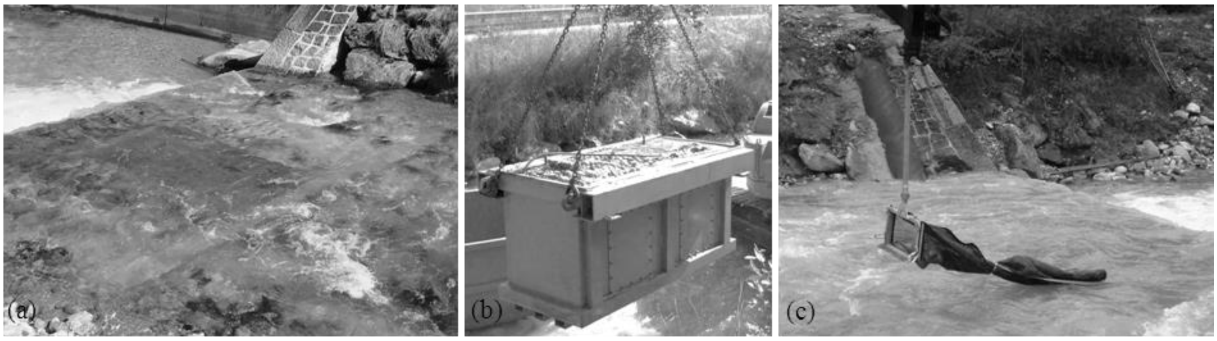

Fig. 1 (a) Geophone device and bedload trap, (b) sample box, (c) mobile basket sampler

Results

This paper presents an applicable method to continuously monitor bedload transport in downstream sections of mountain torrents. The particular methods are discussed, regarding their possibilities and restrictions in bedload monitoring. The importance of an integrative monitoring system, where direct and indirect methods are combined and which aims to compensate individual shortcomings of the applied measuring devices by complementary devices, is demonstrated. The presented and discussed monitoring results of the Urslau torrent include data concerning the spatial and temporal variability of the bedload transport process, information on the initiation of motion as well as quantitative data about (specific) bedload transport rates and bedload yields.
Results of existing approaches to calculate bedload transport are reviewed using measured bedload data of the Urslau torrent. Suggestions to improve the practicable application of these approaches in downstream sections of mountain torrents conclude the paper.

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