Calculating the fluvial sediment output in high mountain catchments

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Abstract: The fluvial sediment output in two high mountain catchments in the Bavarian Alps was determined for each of the sediment components. Suspended sediment load (SSL) and bed load were calculated using rating curve techniques. Dissolved load (DL) was determined by the close relation between electrical conductivity and the concentration of the total dissolved solids.

Key words: rating curve techniques, sediment transport, effective discharge, Bavarian Alps

Introduction

The aim of the research project is to calculate the fluvial sediment transport and to provide a basis for a sediment budget calculation in high mountain catchments. Other geomorphic processes were investigated in the joint project "Sediment Cascades in Alpine Geosystems" (SEDAG) by other project members. Detailed information about rock falls, avalanches, soil slips, slope wash, debris flows and sediment storage types in the two catchments can be found in Haas et al., 2004, Heckmann et al., 2002, Keller & Moser, 2002, Morche & Schmidt, 2005 and Schrott et al., 2003.

Data collection was carried out in three field seasons (2001-2003) in two small high mountain catchments, Reintal and Lahnenwiesgraben (LWG), in the Bavarian Alps about 80 km south of Munich. Measuring stations logging water level, electrical conductivity and turbidity every 15 minutes were installed at the catchment outlets. Water samples were taken automatically, bed load samples by using a portable Helley-Smith sampler. Rating curves were established and used to calculate solid load output. Dissolved load was calculated by using the strong relation between electrical conductivity and total dissolved solids. Calculation of the transported sediment components was not possible on the same level of reliability. The rating curves used for bed load calculation show lower correlations than the event specific rating curves used for the SSL calculation (Figure 1, Figure 2). But all of them are significant on the 0.001 level.

Short scientific paper

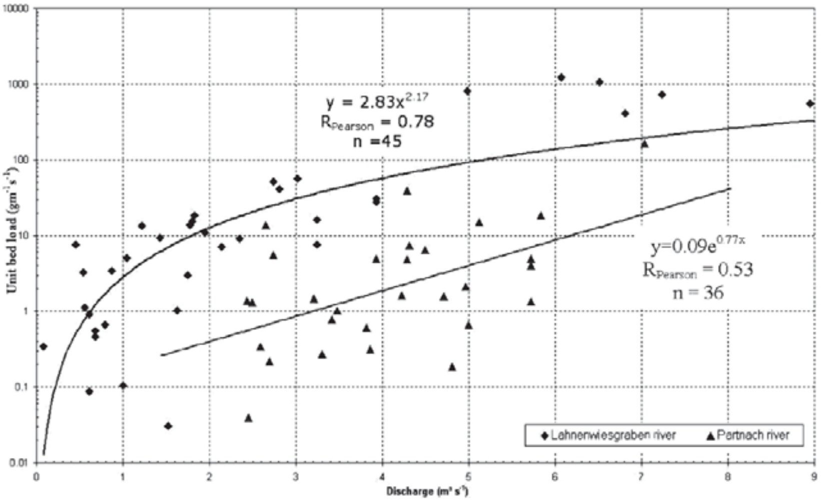

Figure 1. Rating curves for bed load **c**alculation.

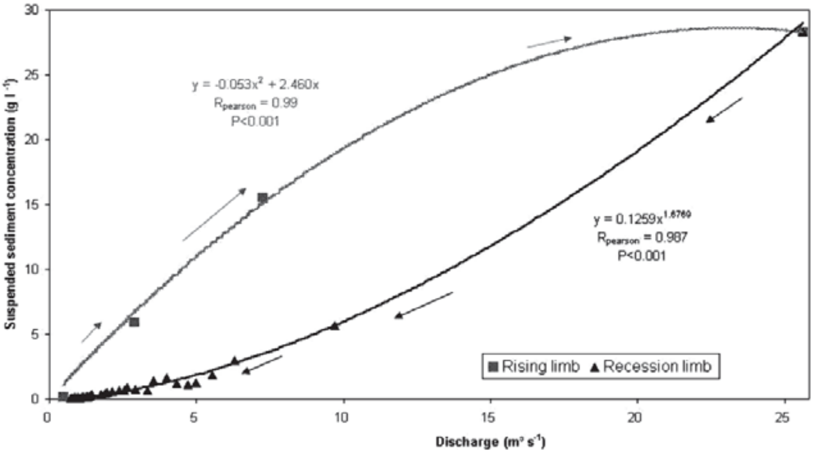

Figure 2. Rating curves for SSL calculation.

RESULTS AND DISCUSSION

The main discharge characteristics of the two rivers are different (Table 1). The Reintal catchment is drained by the Partnach river and about 28 km^2 whereas the LWG catchment is only about 17 km^2. The ratio between maximum and minimum discharge in the Partnach river much lower than in the LWG river. This is due to the fact that the Reintal catchment is a karst buffered system. In the LWG catchment flood events have a shorter lag time after rainstorms. Therefore higher peak discharges occur.

For computing the fluvial sediment output for each catchment data of discharge and concentration of the sediment components

Table 1.

Table 1	year / duration of observation period days	mean discharge ($m^3 s^{-1}$)	peak discharge ($m^3 s^{-1}$)	minimum discharge ($m^3 s^{-1}$)	specific discharge ($l s^{-1} km^{-2}$)	Bed load ($kgd^{-1}km^{-2}$)	SSL ($kgd^{-1}km^{-2}$)	DL ($kgd^{-1}km^{-2}$)	effective discharge (m^3s^{-1})
Partnach (Reintal)	2001/137	2.99	5.56	2.15	106	23	33	773	> 2 and < 4
	2002/158	3.06	11.40	1.76	109	36	236	814	
	2003/108	1.05	2.88	0.52	37	1	6	304	
LWG	2001/137	0.67	10.38	0.09	40	341	493	621	> 20
	2002/207	0.61	25.10	0.14	37	344	4098	574	
	2003/208	0.29	26.13	0.01	17	70	1928	188	

are necessary. Sediment yields were determined for each catchment.

While the LWG catchment is completely coupled with respect to fluvial transport, the Reintal catchment is an example for an uncoupled system. Large rockslide deposits dam the valley floor creating lakes. The sediment transport components have different contributing areas. The whole catchment (28 km^2) contributes dissolved load. Only about 17 km^2 contributes the suspended load. Sediment supply for bed load output from the Reintal basin is limited to only 5 km^2. For comparing the catchments and the observation periods with different duration the mean daily sediment yield ($kg\ d^{-1} km^{-2}$) is chosen.

As Table 1 shows DL is most important in the Reintal catchment, whereas in the LWG river solid load, especially SSL, is predominant. Effective discharge differs between the basins. After Wolman and Miller (1960) effective discharge is the discharge which performs most of geomorphic work. In the Reintal basin more frequent discharges around the mean discharge (between 2 and 4 m^3s^{-1}) are responsible for most of sediment export from the catchment, whereas less frequent events with a high magnitude (>20 m^3s^{-1}) are more effective in the LWG river. The calculated sediment yields are in line with those determined by Becht (1995) for the Bavarian Forealps.

Conclusions

The explanations of predominance of dissolved load in the Reintal catchment and the solid load in the LWG catchment are:
The lithology of the Reintal catchment consists of massive Triassic limestone (Wettersteinkalk). This catchment is a buffered and uncoupled system. The LWG catchment is, beside limestone, built up of unconsolidated rocks and mudstone layers. These sediment sources react susceptible to rainstorm events. In contrast to the Reintal basin the LWG catchment has the character of an unbuffered and coupled system.

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