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Bed morphology response to bedload transport in a small gravel-bed stream

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Forms such as riffles, pools and bars are the main large scale features structuring the bed in many gravelly streams. The occurrence and evolution of these forms are known to be directly linked to the bedload processes by a complex set of influences and retroactions. Estimating accurately bedload transport in gravel-bed streams is still a challenge for fluvial geomorphologists and engineers. Successive morphological surveys before and after flood events are often used to estimate bedload transport rates. This method provides an indirect knowledge on the interactions between morphology and bedload. The objective of this study is to document the morphologic response of a small stream to a sequence of bed load transport events and to compare the morphological method for estimating bedload transport with direct measurements obtained with sediment traps. Beard Creek presents a sequence of autogenic pools and riffles. Bankfull channel width is 5 m and bankfull discharge is 2 cumecs. Median b-axis of the bed surface grains is 40 mm. Three bedload sediment traps measuring real-time rates with load cells were installed in the river bed. A morphological survey followed each flood that occurred during two years and the sediments in the traps were also sampled and sieved. The morphological data was complemented with a survey of bed activity, which consists in estimating the displacement of tags distributed on a one square meter grid 20 meters upstream from the traps. Fifteen effective floods were surveyed and the flood peaks varied between 0.7 and 7 cumecs.

Throughout the survey period, the morphology remained very stable and only one major change occurred. The data show that there is no direct link between bedload rates and morphological changes. Bedload transport rates measured from the sediment traps follow a linear relationship with flood magnitude but the sedimentary budgets estimated from the morphological surveys are very scattered and not related with the bedload rates. The surveys of bed activity are used to interpret these results. The percentage of active bed from the 15 floods varies between 18 and 100% and varies with bedload transport rates. The scatter in the sedimentary budget can partially be explained by the proportion of tags indicating an active bed while there is no significant change in bed morphology. Processes of self-organization maintain the morphological features of the bed independently of the magnitude of bedload transport rates, even for very large floods. This study challenges the usefulness of the morphological methods for estimating bedload transport rates and highlights the importance of studying simultaneously processes driving morphological changes and bedload transport during flood events in order to understand stream stability and sensitivity.