Sediment replenishment by gravel depositsand lateral erosion in Swiss lowland rivers – Physical experiments

Gravel deposit at the River Limmat (Photo: AWEL)

Many Swiss rivers are heavily affected by various river engineering measures and exhibit ecological deficits. Sediment input from upstream is limited by hydropower plants, sediment retention basins and river training measures, resulting in a lack of bed load and morphological degradation. A possibility to improve the sediment balance is sediment replenishment. The source of sediment can be enhanced bank erosion or artificial gravel deposits, which are placed in the river. Pilot projects in Switzerland have shown that the behaviour of artificial gravel deposits and their impact on the river system are not clearly predictable. The main process to entrain sediment from both sources is bank erosion. The mechanisms influencing bank erosion are not entirely known and insufficiently included in most numerical models and therefore not necessarily well predictable.

The goals of this study are to (i) study the erosion process of gravel deposits, (ii) study induced bank erosion, (iii) improve the understanding of fluvial bank erosion in case of non-cohesive, granular material, (iv) provide fundamentals to implement and improve bank erosion in numerical models.

Gravel deposit in the laboratory (Picture: A. Schlumpf, VAW)

Physical experiments are conducted in a trapezoidal channel with a length of 35 m, a bed width of 2 m and a bed slope of 0.17% in the laboratory. Froude similarity has been used to model the Reuss River at a scale of 1:25. Tests are conducted to investigate the influence of the governing parameters, namely the grain size distribution, bulk density, geometry of the deposit and hydraulic load. The investigated hydrological conditions range between a mean annual discharge and a flood with a return period of 30 years (HQ30). Lateral bank erosion rates and the rate of sediment supply to the downstream river reach are determined. Existing equations for lateral bank erosion are evaluated.

As we are using a hybrid approach, numerical simulations were performed in parallel. The bank erosion process was implemented and enhanced in the software BASEMENT to simulate the erosion of the gravel deposits.

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