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Physical and numerical modelling of sediment guiding walls in an alpine river

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The presented work is part of the optimization of the sediment management at the hydroelectric powerplants in Reutte/Höfen in Austria. The weirs of the two powerplants are situated at the alpine river Lech, located about 3 km upstream of the Lechaschau gauge (A=1012.2 km²). Totally five sluice gates and a fixed overflow weir are controlling the upstream reservoir, being subjected to high rates of coarse bed load material. In frame of a coupled approach of physical and numerical modelling, different options to (i) avoid/minimize sediment deposition and (ii) allow improved sediment flushing were tested and optimized. Besides a lowering of energy losses (reduced spilling times) the reduction of depositions downstream close to the turbine outlet were considered.

The physical model covers the hydropower and weir system of both power plants within a stretch of 400m / 150m using a model scale of 1:25. Investigated situations covered periods of reservoir sedimentation, flushing of the reservoir and typical flood flow situations (e.g. HQ1 and an unsteady HQ5 event). For model parametrization, sediment samples to quantify size distribution were taken in the field. Sediment inputs to the model were realized dynamically and were required (due to scaling effects) to exclude cohesive fractions having a minimum particle size of 0.5 mm. The full-area surface measurement of the river bed was made by means of airborne laser bathymetry and echo sounding.

As part of an optimization of the overall sediment management strategy, the focus of the presented research is on the western located runoff power plant Höfen. Via a lateral water intake, a maximum design flow of 15 m³/s is withdrawn causing that the intake structure is subjected to sediment depositions. Within the described scale model (1:25) and a partial scale model (1:15) covering the western side, several management options and configurations of sediment guiding walls were tested. Erosion and deposition as well as the transported material are assessed by 3D laser scanning and permanent monitoring of transported sediment load entering and leaving the scale model.

Complementary, a 2D hydro numerical model using a layer based multi fraction approach for sediment transport is set up for an extended area to simulate the morpho-dynamic behavior. The numerical model covers the whole weir system and 750 m of the upstream part of the Lech. The

simulations made were realized at nature scale and allowed to mimic the erosion and deposition pattern obtained within the physical modelling for different tested options. Regardless of a chosen guiding wall setup, the results showed that each one is compromise between sediment defense and the effectiveness of the subsequent flushing processes.