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Physical modeling of artificial river replenishment techniques to restore morphological conditions downstream of dams

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The river behavior downstream of dams may be strongly modified in terms of morphology, sediment transport and hydrodynamics. Over the last decades, a reduction on the supply of bed load sediments has been observed in these reaches in several alpine rivers. The main effects resulting from the reduction of sediment supply are bed armoring, river incision and bank instability which can affect negatively the aquatic ecosystem. Artificial river replenishment is one of the proposed technique to mitigate the problem of sediment deficit downstream dams and to restore the sediment continuum along these rivers. Many field experiments were performed in Japan and United States and, more recently, also in Europe. Generally, the full erosion of the replenished volumes was rarely observed and the distance travelled by the sediments in the downstream direction was often not sufficient to reestablish natural morphological conditions. In order to improve the practical applicability of replenishment technique a series of laboratory tests are performed with the purpose to investigate the hydrodynamics of the river flow once artificial replenishment is performed. Erodible volumes, reproducing sediment replenishments, are positioned along the banks of an experimental channel. A 15 m long and 2.5 m flume is used to implement two parallel test channels with trapezoidal cross section with a 0.4 m bed width and 2:3 (V:H) of bank slope. Different geometrical combinations of erodible replenishment, in terms of length, distance between volumes and position along the banks, are tested in the experimental flume. For the replenished volumes colored gravel is used which allows the visual tracking of the temporal evolution of the erosion by means of image analysis. The bed morphology is measured at the beginning and end of the tests by a high definition laser scanner. The influence of discharge is evaluated considering different submergence conditions of the replenishment volumes. The first results of the experimental research highlighted the importance of ensuring submerged conditions with sufficient discharge. In case of low discharge, the erosion rate and the traveling distance of the eroded sediments are very limited. The evolution of erosion, the influence of discharge and the distance travelled by the sediments for the different geometrical configurations are presented and discussed.