

Changes to the functioning of a mountain stream following check-dam lowering and installation of boulder ramps

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Because of long-lasting sediment starvation, channel reaches downstream of dams are typically deeply incised and thus the sediment flushed out from the demolished or lowered dams may not be trapped in these reaches but transported far downstream. To enable entrapment of sediment in such a deeply incised channel, artificial boulder ramps were constructed before check-dam lowering in Krzczonówka Stream, Polish Carpathians. Channel morphology, physical habitat conditions, and fish and benthic macroinvertebrate communities in the stream were surveyed prior to restoration activities (2012), after the installation of boulder ramps but with still existing check dam (2013), during (2014) and after the check-dam lowering (2015, 2016). In May 2014, when the check-dam lowering was underway, a large flood occurred, delivering considerable amounts of bed material to the downstream part of the stream. The material was efficiently trapped by the boulder ramps which became buried on the distance of ca. 1.2 km from the check dam, whereas the sediment wave reached 1.6 km from the dam. About 21500 m³ of bed material were retained in the stream during the flood and over the two succeeding years, with an average increase in bed elevation amounting to 0.56 m. A maximum increase in the average elevation of bed surface in surveyed cross-sections equalled 0.96 m at a distance of 160 m from the dam, whereas a maximum increase of the water surface at low flows reached 1 m. Because the sediment was trapped in the deeply incised channel, bed aggradation was not associated with channel widening. The part of the stream with considerable bed aggradation was typified by considerable coarsening of the bed material and a marked decrease in the cross-sectional variation in maximum and depth-averaged flow velocity. In the distal part of the sediment wave, where the change in bed elevation was small, no significant change in sediment size and the cross-sectional variation in flow velocity occurred. The average number of fish individuals, especially juveniles, in a stream cross-section decreased in the years with the construction of boulder ramps, lowering of the check dam and the large flood (2013-2014) but returned to the initial values in 2015 and 2016. The average number of macroinvertebrate taxa in a cross-section decreased in the year with the works to lower the check dam and the large flood but in 2015 and 2016 increased to a greater number than before the restoration works. This study demonstrates effectiveness of boulder ramps in the entrapment in incised channel of the bed material released from the lowered check dam. It also indicates that the restoration works only initiated the change in physical structure of the mountain stream that may lead to the significant improvement of its biocoenosis in the future.