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Use of nature-based solutions for the enhancement of river habitats – transfer of practical experience to scientifically optimized solutions

Andreas C. T. Müller, Christin Kannen, Frank Seidel, and Mário J. Franca

Karlsruhe Institute of Technology, Institute for Water and River Basin Management, Karlsruhe, Germany
(andreas.mueller@kit.edu)

The European Water Framework Directive aims to achieve a good ecological status for all European rivers by 2027. Since the majority of rivers in Germany are in a highly altered state, large-scale restoration projects have been promoted by the federal and state governments. To plan and implement river restoration implies the integration of different interests and constraints such as flood protection, water supply, recreational use and ecology. In particular in urban environments, or otherwise spatially restricted conditions, there are serious problems to reach the ecological objectives which are set by authorities. Thus, the planning engineer is confronted with additional difficulties, especially from human-made contiguous infrastructures. Consequently, it is not possible to develop watercourses through their own dynamics. In these cases, purposefully selected instream structures can be used as alternative means to achieve morphodynamic development and improve the ecological conditions in the existing riverbed.

Until now, many restoration measures by means of instream structures have been implemented empirically according to the experiences by river engineers and technical staff. As a consequence, the guidelines for instream structures provide suitable hydraulic conditions and focus on the technical implementation rather than indicating which type of river habitat can be restored by the selected instream structure. The used measures often showed morphodynamic changes. However, in many cases habitat quality shows only negligible improvement compared to the initial conditions. This demonstrates a lack of scientifically derived solutions that can specifically induce morphodynamic changes and thus create fish and macroinvertebrates habitats in a targeted manner.

At KIT we investigate artificial measures to create functional habitats in pre-alpine to lowland rivers. The investigation is made in close collaboration with governmental bodies who locally specify the ecological objectives guided by the EU Water Framework Directive. An analysis of ecological needs determines the lack of several habitat types in the examined river systems. Together with the state authorities, several types of hydraulic structures such as groynes and other instream structures are then evaluated regarding their ability of habitat replacement.

The selected designs are examined according to state-of-the-art methods of hybrid hydraulic

modelling, including mobile bed experiments, complementary numerical simulations and monitoring field campaigns. Based on the hydraulic findings the habitat suitability for all relevant flow conditions is derived through aquatic habitat simulation. The promising variants are then optimized and evaluated in terms of their ecological impact as well as hydraulic requirements, e.g. flood and bank protection for all morphologically relevant discharges.

The current research shows that nature-based solutions, inspired by practical empiricism and improved scientifically, can be used for developing instream structures that generate purposefully ecologically favourable conditions in rivers. In our presentation we will discuss that with optimization through scientific methods we expect to improve the planning reliability and ecological benefits of the use of instream structures for the enhancement of river habitats.