Abstract

Impact of deflectors on hydromorphological conditions prevailing in a small lowland river on the case of the Flinta River

Anthropogenically modified riverbeds are not able to spontaneously reproduce natural processes. The restoration of natural river systems is an important challenge to contemporary river engineering. The process of river restoration requires various technical and non-technical solutions that minimise interference with ecosystems. One of these solutions is deflectors, which constitute a type of simplified spur that initiate natural fluvial processes. Research carried out on the Flinta River, a typical small lowland river, shows the effects of using deflectors in the restoration process. Two neighbouring sections of the watercourse were selected. The first, the reference section was subject to spontaneous natural restoration. The second section, where maintenance work (including channel de-silting) was carried out in 2011 and three deflectors were installed between 2017 and 2018 to initiate the restoration process. Hydromorphology and macrophyte studies showed that the introduction of the deflectors allowed the initiation of restoration processes, which manifested itself, among other things, in the transformation of the channel geometry, the initiation of meandering and the improvement of the hydromorphological and ecological status of the river. Systematic geodetic and hydrometric measurements carried out between 2018 and 2023 showed significant changes in water flows and shear stresses. The initial increase in water velocity at the deflectors from 0.2 $m \cdot s^{-1}$ to 0.6 $m \cdot s^{-1}$ in the first year after introduction, followed by a decrease in the sections between the deflectors to 0.3 $m \cdot s^{-1}$, demonstrates the effect of the deflectors on the river dynamics. The introduction of deflectors also resulted in an increase in shear stresses (from 0.0241 $N \cdot m^{-2}$ in 2018 to 0.2761 $N \cdot m^{-2}$ in 2023) and local bed roughness coefficients. The sediments analyses showed initial erosion near the deflectors and accumulation of bottom material in the 'shadow' of the deflectors. An increase in grain size downstream of the deflectors from 0.31 mm to 3.90 mm after only two years confirmed the effectiveness of the deflectors in initiating fluvial processes in this local sediment sorting. The studies confirmed that the deflectors support the achievement of good ecological status of the river, as required by the Water Framework Directive (WFD). Using numerical models, it was determined that deflectors do not affect flow conditions during flood events, and their greatest impact is seen at low water levels. The work showed that small and simple wicker deflector structures can effectively initiate and intensify restoration processes, contributing to improving the hydromorphological and ecological status of watercourses. The dissertation consists of 4 thematically related publications. The articles describe in detail all aspects of the river restoration process with the use of deflectors, referring to the research aims and hypotheses in the studies.

Keywords: deflector; ecological restoration; lowland river; hydromorphology; Flinta River; Hec–Ras.