

Significant degradation of ecological state of rivers and increasing flood hazard to their valleys resulting from human impacts on river systems have sparked attempts to restore rivers in many countries. However, only some restoration projects were followed by programmes aimed at monitoring their effects, especially after project completion. Many of the monitored projects showed limited effects in terms of achievement of the expected environmental goals. In the first half of this decade restoration projects were implemented in three Polish Carpathian rivers: the Biała, the Raba and the Krzczonówka using innovative, cost-effective methods (erodible river corridors were created in the Biała and the Raba, and boulder ramps were constructed in the deeply incised channel of Krzczonówka to capture bedload from a lowered check-dam upstream). The Biała and the Raba are relatively large rivers draining the eastern and western parts of the Polish Carpathians, respectively, whereas the Krzczonówka is an example of major tributaries to main Carpathian rivers. The proposed research project will utilize observations carried out at the beginning and at the end of the restoration projects and corresponding analysis performed five years after their completion. This will allow for assessment of the immediate and long term effects of the implemented restoration measures on the flood hazard and on the ecological state of the rivers.

The effects of the establishment of the erodible river corridor on river functioning will be evaluated on the basis of observations performed in the neighbouring channelized reaches and reaches with freely formed channel – in total, 20 cross-sections in the Biała and 12 cross-sections in the Raba. Such study design allows for distinguishing between effects resulting from river dynamics within the erodible river corridor from those induced by variability in climatic and hydrological conditions within the study period. The exception is the Krzczonówka case where restoration measures were applied to a relatively short reach located downstream from rebuilt check-dam. Here, the assessment of the effects of restoration will be carried out based on the observations in 10 cross-sections in increasingly larger distance from the check-dam.

The analysis of the data collected at the cross-sections will allow us to assess the following characteristics of the restored rivers: (i) hydromorphological quality; (ii) physical habitat parameters; (iii) taxonomic diversity of benthic invertebrates and of ecological river state evaluated on their basis; (iv) species diversity and abundance of fish fauna and of ecological river state evaluated on its basis; (v) species diversity and abundance of ground beetles (*Carabidae*) – a group of terrestrial invertebrates typical of riparian environment; (vi) flow velocity, unit stream power and shear stress exerted on river bed and banks at flood flows – that is the parameters characterizing destructive, erosional action of rivers during floods; and (vii) excessive capacity of incised river channels and the associated decreased retention of floodwater on floodplains. The assessment of changes in fish fauna will be done based on electrofishing performed in July and September (seasons of distinct thermal conditions and development stages of juvenile fish). Changes in benthic macroinvertebrates will be evaluated based on sampling carried out in spring, summer, autumn and winter of a given year, and ground beetles will be sampled in spring, summer and autumn. In 2012, a prognosis of bank erosion was made for over 800 segments within the established erodible corridor of the Biała River and this project aims to compare the predicted values with actual bank retreat that has occurred since that year.

Realization of the proposed research project will provide information on the effects of the implementation of the innovative restoration methods on degraded mountain rivers in both short term (4 years of the duration of the restoration projects) and long term (5 years after the completion of the restoration project). Bridging the gap in the knowledge on the long-term effects of restoration measures will be of particular importance as monitoring of restored rivers usually ceases with the completion of restoration projects. Realization of the proposed project will allow for the assessment of the effects of the implemented restoration measures with regard to ecological river state but also the elements of flood hazard. This will show if restoration of degraded mountain rivers through allowing free formation of river channel within the delimited corridor and by construction of boulder ramps in excessively deepened channel can simultaneously improve the ecological state of rivers and decrease flood hazard and by achieving these, thus fulfil the requirements of the Water Framework Directive and the Floods Directive of the European Union.