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The impact of run-off change on physical instream habitats and its response to river morphology

Christoph Hauer and Helmut Habersack

Institute of Water Management, Hydrology and Hydraulic Engineering, University of Natural Resources & Applied Life Sciences Vienna / Department of Water, Atmosphere and, Vienna, Austria (christoph.hauer@boku.ac.at)

Rivers have already been substantially altered by human activity. Channelization, flow regulation, or changes in land use, especially urbanization, significantly alter the water discharge, sediment transport, and morphology of rivers. The impacts of these anthropogenic measures (disturbances) on river morphology and instream habitats were frequently investigated by the scientific community over the last decades. However, there are forms of disturbances (often induced by climate change) which cause at the beginning only a slight but (over the years) a continuous degradation of aquatic habitats (and river morphology). In the presented study the impact of such disturbances caused by climate change on summer run-off was investigated within the Gr. Mühl River catchment, Austria. So far, various studies have documented the impact of run-off change on river morphology and/or sediment load. Further the impact of run-off change on aquatic ecology (target fish species) have been documented throughout various scientific papers. However, there is a lack of knowledge how (climate induced) run-off changes affect instream aquatic habitats concerning various morphological patterns (e.g. riffle-pool morphology vs. plane bed river). Thus, the aim of the presented study was to link the impacts of climate change (e.g. reduced summer run-off) to various morphological types (riffle-pool, plane bed) using habitat modelling (2-dimensional) as integrative evaluation method. As target fish species sub-adult/adult grayling was selected due to the fact, that Thymallus thymallus features especially high sensitivity in water depth (microhabitat use). Further grayling was one the historically dominant fish species for the hyporhithral catchment of the Gr. Mühl River. Within the catchment 80% of the total river length are determined as plane bed river and 20 % as riffle-pool reaches (situated in former fine material deposits). Six reaches (3 plane-bed, 3 riffle-pool) were selected and surveyed by total station (Leica805) to derive high quality DTM-models for modelling. Monitoring data of temperature (period: 1948 – 2006) and gauging data of three stations (Vorderanger, period: 1966 – 2008; Furthmühle, period: 1951 – 2008; Teufelmühle, period: 1951 - 2008) along the investigated reach were additionally provided by the local government agencies. The results of the statistical testing (for significant breakpoints in temperature trends) exhibited significant changes ($p>95\%$) for the seasons spring (year 1989) and summer (year 1990) (increase in regional temperature). Simultaneously, the periods of run-off below statistically determined low-flow thresholds increased significantly especially for summer periods (e.g. gauging station Furthmühle: period 1951 – 1990: n = 684 days / 1990 – 2008: n = 760 days). The impact of those intensified low flow conditions on subadult / adult grayling were (and are) limiting available physical habitats especially within the plane-bed sections (n=3). Only riffle-pool reaches exhibited suitable habitats (evaluated by habitatmodelling) for these dry-periods. However, those riffle-pool reaches are rare and randomly distributed over the 45 km river length (investigated reach). In the presented study it could be figured out, that climate change affects instream fish habitats not only by an increase in water temperatures, but also by limiting physical habitats (in relation to various morphological types). Thus, the response of fish (e.g. grayling) could be on the one hand an upstream migration due to the warmer water temperatures (frequently documented) but on the other hand a downstream migration caused by unsuitable habitats. This second finding should be seen as one crucial point especially for the restoration of regulated rivers with respect to climate change and to fulfil the aims of the European Water Framework Directive.