Sediment continuity – survey, assessment and derivation of recommendations for restoring the hydromorphological indicator

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Introduction: River continuity (for sediments and organisms) is one of the hydromorphological quality elements of the Water Framework Directive (WFD) of the European Commission. The Directive was established in order to protect and improve the waters throughout the EU. The hydromorphological quality elements provide a variety of habitats in river ecosystems, if the hydromorphological conditions are near those that would naturally occur. Sediment continuity is basically ruled by the presence or absence of cross structures in the river. Their barrier effect for sediment transport results often in upstream backwater effects with sediment accumulation and downstream erosion of the riverbed. The sediment budget of a river is closely connected with its hydromorphology. Insufficiently developed hydromorphological features are indicators of a disturbed sediment budget. Vice-versa, the hydromorphological characteristics of the river have influence on the prevailing sediment conditions [1, 2].

Methods: An innovative method was used in the context of the sediment management concept for the Elbe River [3]. The concept is related to the river basin and combines the issues of sediment quantity, hydromorphology and sediment quality as well as use-oriented sediment aspects. Engineering works to adapt the inland Elbe River to the needs of the human society resulted in a degradation of the river [3, 4]. The investigation was focused on the sediment continuity as one of several hydromorphological indicators. Focus on this indicator is of primary importance as lacking continuity of sediment and sediment deficits adversely affect also the other hydromorphological indicators and related habitat conditions. In pilot studies, five representative river reaches of altogether 119 km length were investigated on the Czech side. Additionally, the whole course from the Czech-German border to the weir of Geesthacht was examined in Germany. Furthermore, on the German side the mouths of some exemplified tributaries were taken into consideration over a cumulative reach of 95 km.
A type-specific assessment was chosen, using five evaluation classes in conformity with the WFD. The compatibility of the two national approaches has been verified along the entire transboundary reach from Děčín to Dresden.

Results: The sediment continuity indicator has been calculated for the assessed stretches of the inland Elbe River. The varying spatial distribution of continuity indicator values across the basin is reflecting diverging physiography but also different pressures along the stream. Based on the results of classification the recommendations for actions were made how to deal along the river with the sediment deficit and to improve the hydromorphological status especially for the classes 3, 4 and 5.
Recommendations are for example an improvement of the sediment continuity (cross structures; tributaries; river basin), increasing the sediment load supply or dredged material relocation, e.g. by reactivating from the riparian zone. The trends of reduced sediment supply as a result either of retention in the entire river basin in storage reservoirs, impoundments, river training by bank stabilization and so on and the increased sediment transport capacity of the river due to river-training as well as dyke construction must be reversed [4].

Discussion: The hydromorphological quality elements are used to support biological quality components. Finally, the biological quality element in its most degraded state determines the classification in the relevant status/potential category. Sediment provides habitats for species. At large rivers, there's often a loss of habitats and biological diversity in the river beds themselves as well as along the banks and floodplains. The role of sediments as a vital component in many natural aquatic ecosystems, in turn supporting the delivery of the WFD's hydromorphology objectives, was for a long time not acknowledged. The presented method and the results are a relevant basis for restoring the sediment continuity. Furthermore, it is one of the key-criteria for improving the hydromorphological conditions in general. The results of the case study inland Elbe River provide focus areas for improvement measures to optimize the missing sediment continuity.

References: [1] Quick et al. (2012) *BfG Veranst.* 6/2012:43-62; [2] Langhammer (2013) HEM-S Methodology, Prague 14 pp.; [3] ICPER (2014) Sediment management concept of the ICPER. Magdeburg (German/Czech); [4] Heininger et al. (2015) *Sediment Matters*: 201-247.