

Evaluating quantitative morphological changes of the Lower Rhine with regard to Ecosystem Services

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Introduction:

The hydromorphology of rivers including its sediments is a relevant component of ecological river health and a fundamental issue to providing ecosystem services (ESS). The different services and functions are in close relationship to each other and provide direct and indirect (through the functioning of ecosystem processes that produce the direct services) ESS. Sediments serve f. ex. as construction material and fertilizer and play an essential role for soil and water quality. The hydromorphologic condition represents largely the abiotic habitat characteristics and has a relevant contribution to the biodiversity.

Furthermore, the extensive human use of rivers has further demands to hydromorphological and sediment issues and may come into conflict with the natural system. Navigation, fishing, abstraction, etc. are examples of these ESS and can negatively impact other services. For example, the modified morphological system leads to a reduces regulatory capacity for natural hazards. Erosive, deepened rivers not only pose a threat to the ecosystem and the infrastructure, they are also often no longer visible which affects the cultural and esthetic ESS. [1] [2]

Thus, changes to the sediment status (defined in terms of quality, quantity, location and transport) and the hydromorphologic condition can in- or decrease the benefits the ecosystems provide to the society and need to be managed and evaluated. This is due to the intensive use, especially for federal waterways.

Methods: In this paper different methods are applied to a case study of the Lower Rhine to evaluate and quantify changes of the hydromorphologic condition and the sediment status. In particular, the quantification of changes and dynamics is a good basis for evaluating ESS.

The Valmorph method (= eVALuation of MORPHology) was developed by the German Federal Institute of Hydrology (BfG) as quantitative method for the compilation, calculation and assessment of hydromorphological conditions and changes in and along navigable surface waters, their riparian zones and floodplains. It concerns an indicator-based process. [3]

In the context of investigations on the Lower Rhine (Europe's most used waterway), the Valmorph meth-

od was used and coupled with results of a sediment budget analysis of the River Rhine (from the source to the mouth). [4] One focus of the research was to gain knowledge about the quantitative change of the bed level over time. Comparative conditions for an evaluation have to be derived predominantly from type-specific historical quantitative data analyses. Based on the results, the impact of morphological changes on ESS was analyzed.

Results and Discussion: The investigations enable a process-oriented quantification, evaluation and documentation of hydromorphological and sedimentological aspects. This allows an assessment of the change of ESS over time. In addition, the integration, combination and optimization of quantitative hydromorphological and sediment issues in the management planning contributes to improve the success of measures. The maintenance of federal waterways (f ex. dredging) can be optimized to further ensure the delivery of ESS. Furthermore, the study contributes to validating the results of the individual methods (Valmorph and sediment budget analysis). The approach presented here is used for further investigations in various study areas.

References: [1] Apitz, S. E. (2011) "Conceptualizing the role of sediment in sustaining ecosystem services: Sediment-ecosystem regional assessment (SEcoRA)", *Science of the Total Environment* **415** (2012), 9-30; [2] Koenig F. (2011) "Methode zur hydromorphologischen und soziokulturellen Bewertung urbaner Fließgewässer", *dissertation*, Karlsruhe Institute of Technology; [3] Quick, I.; Koenig, F.; Baulig, Y.; Borgsmueller, C.; Schriever, S., (2017) „The hydromorphological classification tool Valmorph 2 for large and navigable surface waters." *BfG-Report No. 1910*. Federal Institute of Hydrology. Koblenz. [4] Hillebrand, G., Frings, R., (2017) Von der Quelle zur Mündung: Die Sedimentbilanz des Rheins im Zeitraum 1991 – 2010. *Report No II-22 of the CHR, International Commission for the Hydrology of the Rhine Basin. ICPER, 2014.*