

# Assessing success of gravel feeding and long term river management measures with respect to sediment budget and hydromorphology

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**Introduction:** River training measures and sediment retention (e.g. in dams and reservoirs) are some of the main contributors to sediment deficit in waterways and aquatic systems. This occurs when such features increase the transport capacity of the system while at the same time decreasing the amount of sediment available for transport. Possible countermeasures are gravel feeding and river regulation. Such large-scale augmentation projects, however, are costly and faced with huge uncertainties. Fractional sediment budgets can be an important tool in assessing their success and determining the dominant sources and sinks of different grain sizes of riverbed material. In this investigation, we demonstrate the use of a comprehensive sediment budget of the inland reach of the Elbe River as a tool in determining the outcome of long term river maintenance measures. The Elbe is one of the largest rivers in Central Europe. Despite it being heavily regulated by groynes, dykes, and flood protection structures, the Elbe stands out for its natural wetland and forest habitats. Nonetheless, it suffers from a large sediment deficit every year despite ongoing and long term river maintenance.

**Methods:** Changes in sediment levels are commonly assessed from echo sounding measurements. These, however, do not give specific information on the sources and sinks of different grain sizes in riverbed material or the effects of morphological processes on upstream and downstream discharge. The knowledge of these relationships is particularly important for the optimization of sediment management strategies, but can only be answered with the establishment of a sediment balance which integrates fractional contributions of tributaries, flood sedimentation, abrasion and anthropogenic sediment redistribution.

The sediment balance conducted in this study covers approximately 600 km of the inland Elbe (from the German-Czech border to the weir Geesthacht near Hamburg). Indicators derived from the budget are used to assess river state. These include: mean bed level changes and river width variations during a defined period of time, transport capacity as a function of bottom shear stress and grain size composition, average annual suspended and total

bedload as well as corresponding grain size composition, riverbed grain size distribution, fractioned average annual sediment sinks and sources. We compare several representative time epochs (orders of 10 and 20 years) to assess natural variability of the river system and quantify uncertainties. Furthermore, the above-mentioned indicators will be used to assess success of future scenarios by analyzing the geomorphic response to different river management measures, including gravel feeding and river training.

Having such a comprehensive understanding of the morphological processes, especially erosion and sedimentation, and their impact on the sediment balance of the river is of particular importance in achieving adaptive management of large river systems which is vital for economic as well as ecological and social purposes.