Intrusion of fine sediments into low mountain range creeks and associated influence on benthic invertebrate populations

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Introduction: In 2008, a research project of the North Rhine-Westphalian water board Wupperverband in a sub-catchment of the Wupper river basin (tributary of the River Rhine) identified pressures on benthic invertebrates [1]. In addition to the hydraulic pressures caused by variable flow velocities – storm water and combined sewer overflow discharge during wet periods and reduced flow velocities during dry periods – fine sediment intrusion was identified as one of the major reasons for missing the targets of the EU Water Framework Directive.
These pressures were derived from invertebrate Multi-Habitat Samplings [2]. Fine sediments were detected as a major pressure by assessment of habitat requirements and ecological valences of benthic invertebrates, like for example feeding type.
The primary objective of the following study was to verify the above assumption – namely that fine sediments are largely responsible for invertebrate deficits – and to identify the sources of fine particular organic matter. This was achieved through both emission- and immission-oriented analyses of fine sediment intrusion and its behaviour in the water bodies.

Methods: The emission-oriented research programme involved modelling the major inputs of fine sediments from sewage systems, roads and fish ponds (point sources), as well as erosion of agricultural areas (diffuse sources). The fine sediment inputs were quantified by applying a precipitation-runoff model with specific mass surface loading rates [3]. The model was calibrated using several continuous water samplings taken within the river bodies and at combined sewer overflows.
The immission-oriented research programme consisted of 10 periods of sediment trapping at 10 locations [4], 6 freeze core samplings [5] and an extensive colmation mapping [6] of the river beds. A primary goal was to identify those river sections, in which fine sediments settle and thus exert the greatest influence upon benthic invertebrates.
The results of the research programme were compared with the findings of the aforementioned Wupperverband project to identify potential analogies and/or contradictions.

Results: Upon measuring the various inputs, urban sewage systems were identified as a major source of the fine sediment problem within the water bodies studied. Several storm water and combined sewer overflows could be identified as main input sources.
Severe colmation could be determined only at few river sections. The results of the sediment measurements did coincide with biological assessment at some of the Multi-Habitat-Sampling sites.
According to these findings, several measures could be recommended to improve fine sediment retention and foster self-reinforcing river development.

Discussion: Deriving pressures on benthic biota via interpretation of biological sampling plays an important role when defining measures to improve the ecological status of water bodies according to the EU Water Framework Directive. But still great effort is needed to improve these methods to distinguish between the different pressures, which often act in combination on aquatic biota.

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