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Impact of upland erosion and sediment transport on macroinvertebrate communities: An interdisciplinary pressure-impact study in the Kharaa catchment (Mongolia)

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Sediment erosion and transport pathways towards and within rivers are complex as they are dependent on many catchment properties, in particular hydrology and land use. Moreover, fine sediments are a key constraint for aquatic ecosystem functions at the riverbed that potentially alter for example the regulation of biogeochemical processes, habitat suitability for benthic organisms or primary production. Consequently, the understanding of this pressure-impact chain is challenging in order to suggest effective catchment management strategies.

This interdisciplinary study aims to assess system understanding of the interactions of terrestrial sediment transport and the aquatic ecosystem. Therefore, a linked model and monitoring system was developed for the simultaneous analysis of sediment erosion, sediment transport and aquatic ecosystem impacts.

The study area is the catchment of the Kharaa River in Northern Mongolia. This region is influenced by harsh continental climate and because of the long time of nomadic dominated land use, most of the running waters show significantly less anthropogenic influences when compared to Middle Europe. However, analyses of matrix sedimentation traps and macroinvertebrate communities revealed increased fine sediment intrusion in certain river sections. In particular, fine sediment infiltration rates into the river bed and general metrics of the macroinvertebrate community were negatively correlated, i.e. Shannon diversity, Taxa richness, Percentage of EPT individuals (Ephemeroptera, Plecoptera, Trichoptera), whereas a positive correlation was detected for the Percentage of fine sediment colonisers.

Once fine sediment immission was identified as being one of the main stressors for benthic organisms, open questions remained. Namely, these were questions concerning the sources of fine sediment in the catchment, its delivery pathways to the river and its impact on especially the hyporheic zone. To answer these questions a model and monitoring framework was established. Geochemical and fallout isotope (^{137}Cs, ^{210}Pb and ^{7}Be) sediment source fingerprinting is used for spatial sediment source discrimination and to gain information on the importance and proportions of surface-, stream bank and gully erosion in the catchment. Further, two different models are tested to describe the sediment transport in the catchment. The HYPE model is used to model runoff and the associated fine sediment transport in the catchment, and the SedNet for sediment budget calculation. In addition, a two compartment river water quality model including submodels for the hydraulics, fine sediment transport and oxygen balance was conceptualized. Based on that, an intensive monitoring program was developed and applied to investigate across a gradient of impact and for distinct hydrological settings at riffle scale. First results suggest that only a small part of the catchment contributes considerably to the total sediment load and that gully and bank erosion might be the dominating sources in the catchment. Also the erosion behaviour between spring and autumn was found to be different. Data on surface water and subsurface settings showed limited primary production as well as increased fine sediment fractions at the downstream site. The observed decrease of water exchange at that interface needs to be investigated further.

This study results contribute to an IWRM (Integrated Water Resource Management) approach and delivers important information for environmental assessment, management demands and suitable mitigation measures.