SPATIO-TEMPORAL CHARACTERIZATION OF SEDIMENT SOURCES USING CSIA, HIGHLY SPECIFIC BIOMARKERS AND CONNECTIVITY MODELLING

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Slope destabilization and associated sediment transfer are among the major threats for aquatic ecosystems and surface water quality. By modifying erosion risk of soils and the catchments sediment connectivity, land use changes and agricultural practices become a key factor of sediment dynamics. Hence, restoration and management plans of water bodies can only be efficient if the sediment sources and their respective contributions, i.e. the proportion attributable to different land uses and agricultural practices, are identified. Either based on elemental composition, colour, magnetic or isotopic (^{137}Cs) sediment properties, the common fingerprinting methods are not suitable for a land-use based tracing. Since a few years, an organic geochemical approach based on the compound-specific isotope analysis (CSIA; here, fatty acids δ^{13}C) is developed to discriminate source-soil contributions under different land uses. In addition, highly specific (i.e. source-family- or even source-species-specific) biomarkers assemblages, the use of which is until now mainly restricted to paleo-environmental reconstructions, also offer promising prospects for tracing current sediment origin.

We applied this mixed CSIA / highly specific biomarkers approach on three catchments in Midwestern Europe (Switzerland and Luxembourg) as well as on a catchment in South Korea. The method's applicability proved useful in the well-defined and structured catchments of the Swiss lowlands (Baldegg Lake catchment and the Enziwigger catchment, both Canton Luzern) and Luxemburg (tributaries of the Upper Sûre Lake), which suffer partly from a substantial eutrophication and intensive pesticide use due to active agricultural management. The approach was more challenging in the complex terrain of the South Korean catchment (Soyang catchment) where anthropogenic soil movement and replacement as well as very high erosion rates on mountainous terrain are common processes.

Soils, suspended river sediments and, in case of Baldegg Lake, a 130-yrs-old lake sediment core were investigated to assess the molecular and isotopic signature of the potential sources (soils), as well as the short-term (river sediments) and long-term (lake sediments) variations of sediment origin. We separated erosion triggered by storm events from baseline erosional processes by separating suspended sediment samples of base flow and high flow. Within each of the catchments, the soil sampling strategy was defined from (1) land-use data and (2) a sediment connectivity map of the catchment.

Results indicate that we can clearly separate between erosional sources of forest and agricultural land use. Compound specific isotope signals allowed us also partly to unsolve the site specific complex mixing patterns of different cultivation on arable land. For the South-Korean catchment we observed a downstream increasing impact of C4 plants. Further, the CSIA approach indicates that the composition of suspended sediment is dynamic and connectivity of sediment sources changes not only with land use changes but even more so with flow conditions.