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Exploring novel Compound Specific Stable Isotopes (CSSIs) tracers with conventional fingerprinting properties for sediment source apportionment in an arable lowland catchment in Central Germany

Ghulam Abbas[1], Seifeddine Jomaa[1], Patrick Fink[1], Arlena Brosinsky[2], Karolina Malgorzata Nowak[3], Steffen Kümmel[4], and Michael Rode[1]

[1]Department of Aquatic Ecosystem Analysis and Management, Helmholtz Centre for Environmental Research – UFZ, Magdeburg, Germany (ghulam.abbas@ufz.de)

[2]University of Potsdam, Institute of Environmental Science and Geography, Karl-Liebknecht-Str. 24–25, 14476 Potsdam-Golm, Germany

[3]Department of Environmental Biotechnology, Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany

[4]Department of Isotope Biogeochemistry, Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany

Soil erosion and associated sediment transport can cause severe water quality and ecosystems health deterioration. The fingerprinting approach has widely been applied for sediment source apportionment using a variety of sediment tracers. This study evaluates the applicability of the Compound Specific Stable Isotope (CSSI) fingerprinting technique of fatty acids to identify crop-specific soil loss and the importance of upland erosion compared to river bank erosion. We tested this new technique with fallout radionuclides, geochemical and spectral tracers in a small agricultural loess soil catchment (Geesgraben, 75 km²) within the lowland Bode river catchment in Central Germany. The CSSI tracer was combined with a linear multivariate mixing model to discriminate soil loss from areas with specific crop types (e.g., C3 vegetation/wheat and C4 vegetation/maize) and identify the share of river bank sediment source on total sediment loss. We compared the CSSI technique with fallout radionuclides, geochemical and spectral fingerprinting properties for tracing subsurface sediment sources. We found that the CSSI fingerprinting technique of fatty acids allowed to decipher surface sediments from wheat and maize fields. The CSSI δ^{13}C-fatty acids were also used to disentangle arable and river bank sediment sources. The crop-specific soil loss from wheat and maize was 40% and 11%, respectively. Relative sediment contribution from river banks was up to 49%. The outcomes using the CSSI tracer were consistent and similar to those using fallout radionuclides, geochemical and spectral fingerprinting properties for arable land and river bank sediment sources, which indicated a mean sediment source contribution of 46% from river bank and 54% from surface sources, respectively. Our results showed that the stable isotope composition of fatty acids could discriminate C3 and C4 vegetation sources, and such information is of prime importance for decision making. Furthermore, the relatively high proportion of sediment losses from river banks has clear implications for management measures to reduce sediment losses in these agricultural loess areas.

Keywords: sediment fingerprinting, CSSI, fatty acids, C3 and C4 vegetation sources, sediment

sources.