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Plants, bacteria or algae – Searching the bias in sediment apportionment in a varved sediment record from a eutrophic Swiss lake.

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Varved lake sediments are very often used as environmental archives, since the yearly temporal resolution of these archives is giving us some unique insights in past environmental and climate settings and changes. We use sediment records as an archive for erosion dynamics and thus to potentially trace back land use changes at the catchment scale.
Land use changes and agricultural practices become nowadays a key factor of sediment dynamics by modifying the soils erosive risk and the catchment sediment connectivity. And while soil erosion is one of the biggest threats to soil fertility as well as to ecological health of freshwater systems, 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.
To tackle this problem, we applied a compound-specific stable isotope approach ([U+F064]13C of long-chain fatty acids (FA)) combined with connectivity modelling and biomarker analysis to a 130-years old varved lake sediment core from a eutrophic Swiss lake. Todays "source" soils with different land-uses (permanent and non-permanent grasslands, arable lands, orchards, and forests) were discriminated by using the compound-specific [U+F064]13C signature fingerprint of C26:0 and C28:0 FA. FA analysis of the lake sediments samples, covering the last 130 years, enabled us to apportion the sediment origin to the sources and follow the erosion dynamics of the catchment back in time. Mixing models like MixSiar give us the possibility to calculate the contribution of the different land-uses to the sediments. For the time window 1940 until 1960 we identified forests as the main source of the terrestrial sediment origin. Actually 80 to almost 100% of the fatty acids origin could be attributed to the forests. For the younger sediments a clear change in sediment origin happened. The influence of arable land and grasslands was increasing compared to forests. But quantitative attribution and differentiation between grassland and arable land contribution were difficult due to the linear distribution of the CSSI signal of different source soils in the isoplot.
However, limitations in using this method became obvious for sediments older than 1940. The isotopic signal of these sediments could no longer be explained by today's terrestrial sources. Additional sources of the assumed terrestrial long-chain fatty acids were hypothesized. We discuss a potential bias of the terrestrial fatty acid signal by (1) historical peatlands, (2) in-situ FA production by algae and (3) in-situ production of FAs by methanotroph bacteria.
The dynamic of sediment origin over time revealed through this integrated source-to-sink study could serve as a basis for future management options to reduce sediment inputs to rivers and lakes.