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Historical gully erosion in central Germany reconstructed by lacustrine sediments

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The formation of lacustrine sediments is controlled by geology, climate, geomorphology and vegetation as well as by human impact. Paleolimnological studies thus provide valuable information about the natural variability of background conditions, for example of climate or nutrient conditions prior to human influence. In addition, various types of human impact on lake systems are identified in lacustrine sediment records. Land-use change has been recognized as one of the most important anthropogenic impacts on lake systems, with soil erosion being a direct consequence of anthropogenic forest clearance and related land-use activities. Soil erosion is by no means solely a consequence of modern agriculture, but has been acting as the dominating shaping factor of the present-day cultural landscapes in Central Europe. Methods to identify periods of enhanced soil erosion include the analysis of soils, colluvial deposits, fluvial sediments and erosional features such as gullies. When applicable and if compared with other records, lake sediments generally provide the most detailed information based on the continuity of the sediment record, and on the high temporal resolution. In addition, lacustrine sediments contain several types of environmental indicators, making it possible to gain supplemental information from multi-proxy investigations.
Here, we discuss the potential of lacustrine sediments from the lake "Bernshäuser Kutte", located in southwestern Thuringia (Germany), to reconstruct historical gully formation. Arable land has been in close vicinity to the lake, thus minimizing cascading effects and intermediate sediment storage as it is typical for larger depositional systems. Furthermore, surficial outflow and thus the loss of suspended sediment is negligible, which maximizes the trap efficiency of the lake basin for eroded soil particles and thereby allows a quantification of gully development with a high temporal resolution. Gullies with a depth of several meters discharge directly to the lake basin and suggest intensive soil erosion processes during historical times. A gravity core with a total length of 130 cm from the central part of the lake covers approximately the last 350 years. The chronology is based on 137Cs and 210Pb radionuclides, AMS 14C dates on terrestrial macrofossils and on paleomagnetic dating. The lower part of the record consists of finely laminated silts and clays which are interrupted by massive turbidites. These turbidites are characterized by sandy basal layers and a fining-upward sequence into a clayey top layer. This indicates extreme erosion events and active gullying in the lake catchment area during Late Medieval and Modern Times and prior to the era of industrialization. At 50 cm sediment depth (ca. 1910 AD) the lithology changes to organic-rich, sapropelic sediments which coincides with a decrease in cereal and grass pollen percentages. This inferred land-use change, which might be related to lower pressure on land-use because of the emigration of local rural population to overseas, caused a diminished input of minerogenic matter into the lake and a de-activation of the gully systems. These first analyses reveal that the catchment area of Bernshäuser Kutte is particularly well suited to investigate historical (gully) erosion.