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Contribution of bank erosion to the sediment budget of a drained agricultural lowland catchment

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Following the shift towards more intensive agriculture in cultivated lowlands in Europe, field sizes have increased and stream valley meanderings have been removed and realigned along new straight field borders. These modifications have led to profound alterations of the hydromorphology of the streams. To test the impact of these modifications, the long-term and current volumes of sediment originating from stream banks were calculated as they provided potential sources of sediment in a large pond located at the outlet of a small agricultural lowland basin under strong anthropogenic pressure. Bank erosion was measured using several methodologies, i) over a short period using a set of erosion pins along a small stream (1400 m long) to quantify the material exported during a single winter season (2012/2013); ii) over the last 69 years using an original approach involving the comparison of a compilation of three-dimensional historical stream redesign plans from 1944 vs. new measurements conducted in 2013 (DGPS and LiDAR data); iii) over several decades by using tracers (137Cs) that can differentiate between surface and subsoil erosion. At the catchment scale, total sediment exports were estimated from 1945 to 2013 combining seismic imagery and core dating in the lake.
Sediment exports decreased with time, from 300 t. km–2.yr–between 1954 and 1980 to 95 t. km–2.yr–1 between 1980 and 2013. Today, erosion rates recorded at the outlet of the catchment vary between 90–102 t.km–2.yr–1. Therefore, the order of magnitude of the mean export rate is approximately 180 t. km–2.yr–1 for the last 70 years. The contribution of channel banks to this sediment export was the highest (∼30%) between 1954 and 1980 when the ditches were constructed. For the entire period since the landscape modification, the contribution of bank erosion is lower but still reaches 20%. Bank erosion can therefore be considered as a significant contributor to the sediment budget of the lowland catchments that have been redesigned after the 2nd world war in Western Europe.