Hydro-sedimentary dynamics of a drained agricultural catchment: a focus on tile drainage

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Rural landscapes were extensively modified by human activities in Western Europe since the beginning of the 20th century. Cultivated areas expanded in wetlands traditionally used as grassland. These expansions were associated with extensive anthropogenic modifications of the landscape, for instance through the implementation of artificial tile drainage networks, increasing water drainage from soils.

These networks increase the water and sediment connectivity from plots to rivers, creating new transfer pathways beneath the soil surface. As traditional soil conservation measures, such as grass strips, were designed to limit transfers by surface runoff, tile drain make sediment particles bypass these measures. Moreover, these transfers mobilize small particles (in the order 10^{-5}-10^{-6} m) with a high adsorption potential, making them possibly detrimental for the environment. It is therefore crucial to understand the water and sediment transfer dynamics occurring through tile drainage, and their importance at both the plot and catchment scales. Although tile drainage was studied at the plot scale, for instance to analyze nutrients transfers, the high frequency behavior of sediment transfer from tile drainage, and its potential impacts at the catchment scale, is still poorly understood.

Our research quantified sediment fluxes with a high frequency (10 minutes time step) during three years at five nested stations including a tile drain outlet across a small (25 km^2) agricultural catchment (Loire River basin, France) representative of lowland cultivated environments. This catchment was largely modified by anthropogenic features: streams were redesigned and more than 67% of the fields are equipped with tile drainage networks.

Flows from the drain were measured during 11.4% of the monitoring time. The nested tile drainage-catchment monitoring network allowed quantifying both the sediment fluxes from tile drain, an often overlooked process, and its proportion in the associated catchment sediment fluxes. Most of sediment fluxes (79 ± 9%) were measured during flood events (n = 44), mostly occurring in winter (75%) and spring (20%). Seasonality therefore controlled most of the variations of sediment fluxes in this context, meaning that the hydrosedimentary response of the catchment should be studied during long observations periods.