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Combined effects of dam removal and past sediment mining on a relatively large lowland sandy gravel bed river (Vienne River, France)

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Dam removal is of growing interest for the management of sediment fluxes within fluvial basins, morphological evolution and ecological restoration of rivers. If dam removal experiments are now quite well documented for small streams located in the upstream parts of river networks, examples of lowland and relatively large rivers are still scarce. In this study we present a dam removal operation carried out on the Vienne River (France) to restore both sediment and biotic continuity. The Vienne River is 363 km in length. On its middle reaches the average slope is equal to 0.0003 m.m-1 and the average annual discharge is 195 m3.s-1 at the gauging station of Nouâtre. The river is characterized by a sinuous single channel of an average width of 150 m. The sediments are mainly made of a siliceous mixture of sands and gravels and were intensively mined between years 1930 and 1995's.
In 1920, a 4 m height dam was built just downstream the confluence between the Vienne and Creuse Rivers triggering a total sediment deposition upstream of 900 000 m3 in 75 years. Hence, in 1998, the removal of the dam increased severely the sediment supply delivered to the Vienne River. The objective of this study is to understand and quantify the fluvial processes and morphological evolution on a reach of 50 km of the Vienne associated with the dam remova and the presence of ancient sand pits located along the riverbed. This study is based on field data collected during 7 surveys performed between 1998 and 2013. This large dataset focuses on bed geometry (detailed bathymetrical surveys), sediment grain size, and bedload fluxes measured using isokinetic samplers. It was combined with a 1D numerical model developed to assess flow dynamics and sediment transport capacity before and after dam removal.
Results show that dam removal triggered both headward and progressive (near the dam) erosions and that discharges higher than 100 m3.s-1 were sufficient to erode the sandy sediments trapped by the dam whereas gravels were mobilised for discharges higher than 300 m3.s-1. Since 1999, large bedload sediment waves coming from upstream the dam migrated downstream at an average celerity of 2.5 km.year-1. Most of these bedload sediments where trapped by three ancient sand pits located downstream. Some of these pits constitute efficient sediment traps even 15 years after dam removal. As a result, between 2002 and 2013, the slope of the river bed adjusted gently and observed scour and fill proccesses were minors compared with the time period between 1998 and 2002.
This study is original since it documents the adjustment time (on 15 years and 50 km) and the intensity of morphological processes which affected the bed of a relatively large lowland river, the Vienne River, after a dam removal experiment.