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Reconstructing the discharges and geomorphological impacts of artificial floods using archives and field surveys. The case of timber floating in the Yonne Basin, France (16th – 19th centuries).

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Timber floating became a major industry in the Yonne basin between the 16th and 19th centuries due to the rapid growth of Paris and its increasing energy needs. The Yonne River is a tributary of the Seine basin. Its source is located in the Morvan region, a granitic small massif in the south eastern part of the basin. Logs were transported by floating from the production area in the upper valley to Paris through the Yonne and the Seine rivers. In order to ease log transport in the steep and narrow headwater streams, river channels were reshaped and artificial floods were regularly created from small reservoirs obstructing the very top of the valley. The extent and the duration of the timber floating industry led to major geomorphological, hydrological and ecological perturbations to the river system. In order to study the impacts of this industry we tried to reconstruct the artificial conditions of flow during the floating period using archives and field surveys.
The reservoirs were located and dated using archives and historical maps in order to evaluate the modifications to the hydrological regime. At the end of the 18th century, reservoirs were present on every little tributary of the upper valley. Their volumes were reconstructed based on the areas of the reservoirs and the heights of their dykes. From historical data, we know that it only took a couple of hours to empty the reservoirs and a couple of days to fill them. Over decades, between November and February the reservoirs were emptied as often as possible (probably several times per week).
Small steep and incised streams of no more than 5 m wide regularly experienced discharges of 2 to 3 m3/s on average. The energy associated with the discharges in these small streams is very high: stream powers range between 250 and 400 W/m^2. In such conditions, the streams should have been able to transport pebbles and boulders of 15 to 35 cm in diameter and therefore induce very high sediment transport rates.
Further downstream, the channel of the main valley is narrower, the slopes are less steep, the valley is larger and there is a floodplain. In order to prevent the loss of logs on the floodplain, the artificial water releases were controlled in order to maintain the water level beneath the bankfull. Artificial discharges were between 3 and 5 m3/s. This corresponds to an ordinary discharge with a stream power of 30 to 70 W/m^2. Nowadays, this discharge is reached about 30 days per year but it was considerably more frequent during the floating period. Such floods should have been able to transport much smaller pebbles of 4 to 8 cm in diameter. Sediment transport rates were therefore much more limited in the main valley than upstream.
As a result of the timber floating industry, the upper valley of the Yonne has experienced a sedimentary wave descending from the headwater streams to the main valley. Headwater streams display incised morphologies and the present-day riverbeds are several meters lower than the riverbeds present prior to the timber-floating industry. Over decades, a very large volume of coarse material was carried downstream to the main valley. There, due to the lower energy of the flow, the sediment was deposited in the riverbed, preventing its incision.