Reconstruction of the historical evolution and present-day functioning of a highly impacted river and assessment of sediment injections as a restoration measure: a case study of the Péage de Roussillon reach along the Rhône river (France) using the 1D basement model.

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Our study focused on the Péage de Roussillon reach in the Rhône river, approximately 50 km downstream of Lyon (France). We applied the 1D Basement software to study the response of historical changes on the riverbed in order to establish a reliable and robust present-day model. Then, we used this model to simulate several scenarios of sediment injections for restoration.

We studied the impact of river narrowing, diversion dams with flow regulation and local dredging within our 30-km long reach. The reach is bound between two dams, where upstream we have 2 parallel channels (the 'Old Rhône' and 'Canal Rhône') regulated by the upstream dam. The channels join together at the confluence into the 'Total Rhône' where the backwater effect of the downstream dam creates a long reservoir. Further, there is a weir present in the Old Rhône to maintain a certain water level upstream.

The model was constructed and validated using a large data set available through the Rhone Sediment Observatory (OSR) that includes historical and present-day bathymetry, grain size distributions, flow duration curves, 1D hydraulic model outputs, and dredging locations and volumes. We built a simplified grid, with rectangular cross sections using averaged widths for the entire reach (or sub-reach) and starting from a fixed slope. This allowed us to disentangle the effects of simultaneous impacts on the riverbed. We hypothesized that the present-day load is a reasonable first-order approximation for the historical load and that measurements of the subsurface grain size distribution of bars are a reasonable proxy for the grain size distribution of the historical load. We used the analytical approach of Blom et al (2017) to back-calculate the grain size distribution of the historical surface layer.

Historical bathymetric and present-day granulometric data were used to validate the evolution of the bed over time. The results showed a mobile armour since embankment and a stable slope. The present-day riverbed obtained from simulation indicated a near-equilibrium condition, in agreement with the observations. Sediment reinjection simulations have shown a very slow redistribution of the reinjections which was also observed through PIT-tag measurements. The different reinjection scenarios present the redistribution over space and time in relation to changes in the flow regime and sediment supply and volume and grain size distribution of the reinjected material.

This model presents a first step in predicting bed evolution in relation to management decision making. In the next step other reaches will be introduced in the Rhône river following the same model steps.