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Space-time scale dependences phenomena in the framework of river restoration projects - the "Lac des Gaves" case study

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The "Lac des Gaves", an artificial lake located in the main stream of the "Gave de Pau" river in the high Pyrenees, has gone, like many rivers and lakes worldwide, through very intensive sediment extractions over the past century. These activities led to the construction of two weirs, one upstream and one downstream the lake, in order to stabilize the riverbed. This resulted in the lake acting like a sediment trap causing a brutal longitudinal profile discontinuity that leads to an increasing risk of river diversion toward populated areas, destruction of hydraulic structures' foundations, shrinkage of the active channel, global incision (more than 3 meters), etc. Considering the multi-criteria character of this study dealing with security of goods and people, environmental preservation, investment costs and ecological and sediment continuity, a deep analysis of the lake's historical evolution until its current situation is needed to be able to propose sustainable and efficient restoration solutions.
To be able to understand the current situation and predict the future behaviour of the study area after its restoration, we decided to analyse, in a complementary way, its historical and experimental hydromorphological characteristics. As a matter of fact, many river restoration projects have proved that the consideration of these two approaches can be very useful to help design well suited solutions for a given river reach. Thus, a diachronic analysis is currently ongoing based on an important amount of historical data (such as: flow data, aerial photos, field data, etc.) collected from the archives of all the former river basin management structures and integrated in a computer database. The aim of this work is to study the hydromorphological evolution of the river reach from its natural state to its current modified state. This step of the project aims at identifying the most relevant indicators that will be helpful to test the performance of the proposed restoration solutions.
Next, the importance of considering upstream/downstream dependences was stressed up. A numerical approach coupled with an experimental approach at the catchment scale were thus considered. On the one hand, to better estimate sediment supply coming from upstream watercourses, an in situ sediment transport monitoring protocol with coloured plots installed in the emerged bars, topographic survey and quantification of the bed load thanks to a Helley-Smith sampler was developed. This acquired field data will be useful to evaluate the predictive capacities of the numerical models that are being developed. Since there is a lack of flow data upstream to interpret sediment transport phenomena, the hydrological events that led to sediment mobility are simulated with the physically based hydrological model MARINE at the catchment scale. The outcomes will be necessary to compute bed load trends upstream by simple calculations (empirical formulae) and feed the diachronic 2D morphodynamic model that is being developed at the studied reach scale.