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Instability of a gravel-bed river bifurcation. Field measurements and numerical modelling

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This research aims to study the stability of a gravel-bed river confluence. Particularly, we explore the siltation processes of an auxiliary channel (400 m-long, 10 m-wide, 2 m-high) built on a lateral alluvial bar of a river and designed to alleviate bank erosion risks on the main stem. The study area is located on the Gállego River, a meandering gravel-bed river draining the Southern Pyrenees, and tributary of the Ebro River, the largest river in Spain. Severe incision (more than 3-4 on average) occurred along the study reach due to extensive in-stream gravel mining during the 60s-80s. Although the river is regulated by three dams, its lower reaches are still dynamic: channel avulsions, meanders migration and other river processes are often observed during floods. In this research, we focus in particular on the effects of an ordinary flood occurred on November 2016 (Q_{peak} = 354 m^3/s, similar to bankfull discharge) which silted up the auxiliary channel built in August 2015. A comparison of bed topographies demonstrates that channel sedimentation was not uniform (more sediment was accumulated at its central parts) and it occurred simultaneously with channel widening. This research is based on combining field data collection and analysis and numerical modelling. Field data include: i) bed topography at different times, ii) sediment surface and sub-surface samples, iii) stratigraphic records of the material deposited on the auxiliary channel during the flood, iv) velocity and topographic measurements at the bifurcation, v) bedload samples and vi) comparison of aerial photographs. This information is used as input data for an *ad hoc* one-dimensional morphodynamic numerical model. The mathematical model is based on sediment transport capacity principles. By incorporating modelling results from nodal points at bifurcations and by including sediment mixtures, the numerical modelling is able to predict channel sedimentation during the November 2016 flood and to explain why differences in sediment supply and sediment transport capacity on the auxiliary channel turned out in an unstable bifurcation.