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LiDAR-derived morphological changes of gravel-bed rivers in the French Prealps

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The recent development of innovative topographic survey technologies offers new opportunities for investigating spatial and temporal patterns of gravel-bed rivers morphological responses to flow events. In this study, multidate airborne LiDAR surveys were used to reconstruct reach-scale morphological changes in two gravel-bed rivers following important floods.

LiDAR surveys were acquired simultaneously for a 7 km reach of the Bès River and a 3.1 km reach of the Bouinenc Torrent, which are two tributaries of the Bléone River in the Southern French Prealps. The Bès is a very active aggrading braided river (drainage area: 234 km^2) whereas the Bouinenc is a wandering gravel-bed stream (drainage area: 39 km^2). LiDAR surveys were done in October 2008 and June 2010. During this period, a 15-year flood occurred in the Bès River and several floods of moderate intensity occurred in the Bouinenc Torrent.

LiDAR data were post-processed following several steps. First raw data were automatically classified into ground and no-ground points with the Axellson's automatic filter of the TerraScan software. Secondly DTMs (Digital Terrain Models) were constructed with ArcGIS using a simple workflow in which survey points were used to derive a triangular irregular network (TIN) using Delauney triangulation, which was then linearly resampled onto a 1 m^2 grid. Lastly a DEM of difference (DoD) is produced by subtraction of DTM pairs and DoD spatially distributed error was accounted with different methods recently developed. Scour and fill volume estimations are used to calculate sediment budgets. The scour and fill maps allows reconstructing erosion and deposition of macroforms and to classify bedforms according to their morphological response. These bedforms are also described by different factors like their morphology, their position and elevation relative to the main low flow channel and their vegetation cover. Final aim is to link bedform characteristics with their morphological response.

We showed that the braided channel of the Bès River underwent significant bank erosion, and channel scour and fill during the flood. The Bès River recorded a positive sediment budget of 50 216 m3, calculated by a gross subtraction of DTM pairs. Scour and fill volumes are 125 582 m3 and 175 798 m3, respectively. The channel of Bouinenc Torrent underwent fewer changes. Significant bank erosions are clearly visible but channel scour and fill are small. We calculated a low gross negative sediment budget of -992 m3. Careful attention still needs to account spatial errors from DEM of difference. This step is crucial to improve these gross sediment budgets and to detect real morphologic changes so as to correctly study bedform dynamic.