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Morphological changes analysis of gravel bed rivers through comparison of DTMs (DoD): integration of LiDAR data, DGPS survey and aerial photo.

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The extension and volume of erosion/deposition processes affecting gravel-bed rivers after floods can be assessed in a very accurate way on the basis of digital terrain models derived from LiDAR surveys developed before and after flood events. When LiDAR surveys are acquired without using the bathymetric option (red laser), the uncertainty related to the estimation of the bed surface underwater may increase substantially. A relatively novel method to develop more precise and detailed DTMs is to integrate LiDAR-derived elevations of dry surfaces with water depth of wetted areas derived from aerial photos and a predictive depth - color relationships. This approach has been applied to eight different sub-reaches of three gravel bed rivers featuring in North-Eastern Italy (Brenta, Piave, and Tagliamento), before and after the flood events occurred in November and December 2010 (recurrence intervals > 10 years). The key of this methodology consists in the calibration of a regression model between depth values of Differential Global Positioning System (DGPS) points and Red, Green and Blue (RGB) bands values of aerial photos, contemporary to the LiDAR flight. The regression model calibrated for each river and each year, estimates the quota (Z coordinate) in respect to the reference plane, for each RGB pixel of the channel. Final DTMs (uncertainty was estimated about $\pm$ 25 cm) include detailed representations of flood-plains and active channels, that have been used to evaluate the morphological evolution of the rivers as effect of floods through the difference of DTMs (DoD). The erosion-deposition volumetric results derived from the two-years DoD differencing models have highlighted the impact of the two flood events. In all the sub-reaches, erosion processes have dominated. The quantitative results of morphological changes at sub-reach level show different intensity of the processes, as result of the diverse site conditions and the historical channel-adjustments.