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Bathymetry with LiDAR on gravel bed-rivers: Quality and limits

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Bathymetric and topographic data on river beds are key description elements for hydro-morphology and hydro-ecology. When dealing with bathymetry on gravel bed rivers, we usually face half-meter mean water depths. On such very shallow waters, the performances of hydrographic airborne LiDAR for bathymetry and topography are still uncertain. This technique, initially developed for coastal surveys, i.e. slopeless water surfaces and useless very shallow waters, has been, up to now, poorly applied on rivers. The system limitations and measure quality must be assessed for river applications. Moreover, how to assess the quality and the limitations of the altimetrical LiDAR data (bias, dispersion) when comparing DGPS punctual measures to several meters laser footprints on river bed ? In this study, we assessed the quality of the bed topography measured with the HawkeyeII Hydrographic LiDAR system when dealing with very shallow waters and using a specific multi-scale method. This assessment settled on a 3 km segment of the Gardon gravel bed river, south of France. This river has clear waters, 0.59 m mean water depth, 43 % of surface less than 0.4 m depth and local pools up to 4 m depth. 7824 DGPS points pseudo-regularly located along river space were acquired at the same time as LiDAR survey. Hence, we developed a geostatistical method to compare reference data coming from DGPS points to LiDAR ones. This method is using anisotropic block kriging of DGPS points on LiDAR footprints

geometries based on local variograms characterising river bed rugosity. Results show unconstant mean errors and dispersion errors (of 0.32 m) regarding water depths. The optimum water depth for LiDAR measure is directly related to a priori LiDAR calibration regarding water turbidity. However, this test showed a global good correlation between the river bed forms based on LiDAR data and DGPS data. It also allowed to obtain a continuous topographic surface, from locally deep waters to riparian areas.